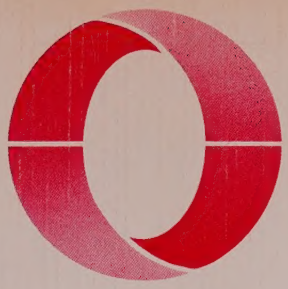


Macbeth
Color &
Photometry
Division

OF KOLLMORGEN CORPORATION

GENERAL ELECTRIC CO.
LOS ANGELES INSTRUMENTATION
11223 SOUTH HINDRY AVE.
LOS ANGELES, CA 90045

QuantaLog® Portable Reflection Densitometer RD-505

Operator's & Service Manual

CHANGE NO. 1

DATE Sept. 3, 1970

INSTRUCTION BOOK CHANGE NOTICE

MANUAL AFFECTED RD-505 (ISSUE DATE: 7/70)

Page 6-4. PARTS LIST.

The "DESCRIPTION" and "MANUFACTURER" entries for Ref. Symbols R103 through R107 should be changed as indicated below.

REF. SYMBOL	MACBETH PART NO.	DESCRIPTION	MANUFACTURER
R103	36162000	RESISTOR, THIN-FILM CONST: 1.65K ohm, ±1%, RN55D	Texas Inst.
R104	36512001	RESISTOR, THIN-FILM CONST: 5.1K ohm, ±1%, RN55D	Texas Inst.
R105	36602000	RESISTOR, THIN-FILM CONST: 6.04K ohm, ±1%, RN55D	Texas Inst.
R106	36761000	RESISTOR, THIN-FILM CONST: 768 ohm, ±1%, RN55D	Texas Inst.
R107	36332003	RESISTOR, THIN-FILM CONST: ±1%, RN55D	Texas Inst.

CHANGE NO. 2

DATE October 16, 1970

INSTRUCTION BOOK CHANGE NOTICE

MANUAL AFFECTED RD-505 (ISSUE DATE: 7/70)

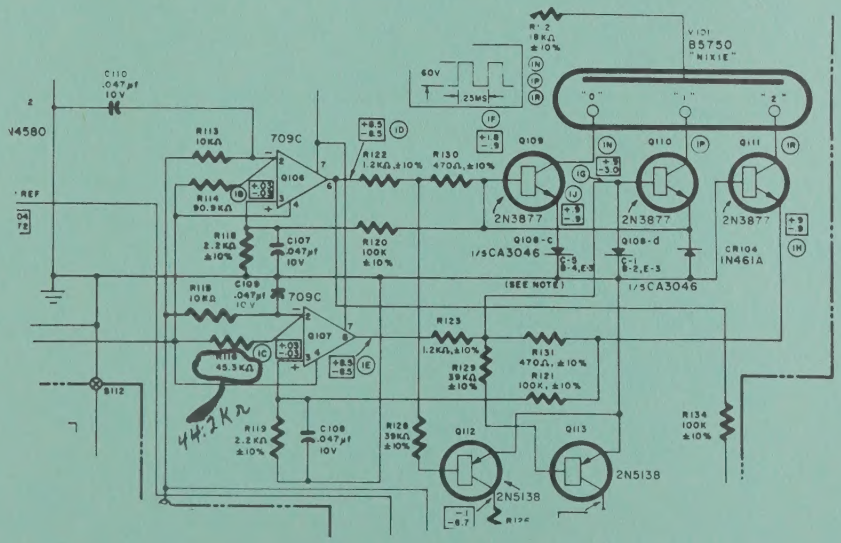
1. Page 6-5. Parts List

Change the part number and description entries for Ref. Symbol R116 as indicated below.

REF. SYMBOL	MACBETH PART NO.	DESCRIPTION
R116	36443000	RESISTOR, FIXED, COMP: 44.2K ohm, ±1%, RN55D

2. Page 7-2. Figure 7-1

Change R116 to 44.2K ohm as shown below.



CHANGE NO. 3

DATE October 27, 1970

INSTRUCTION BOOK CHANGE NOTICE

MANUAL AFFECTED RD-505 (ISSUE DATE: 7/70)

1. Page 3-6. Paragraph 3-5. BATTERY TEST.

The last sentence of paragraph 3-5 should be deleted and the following information should be added:

"If the Nixie tube indicates "2" and the meter pointer is to the right of "BATT: (i.e. combined digital and meter display equals 2.2), the charge condition of the cells is satisfactory. If the combined digital and meter diaplay is less than 2.2, the cells need to be recharged (refer to paragraph 5-1d).

CHANGE NO. 4

DATE Nov. 23, 1970

INSTRUCTION BOOK CHANGE NOTICE

MANUAL AFFECTED RD-505 (ISSUE DATE: 7/70)

1. Page 5-7. Paragraph 5-3b. REPLACEMENT OF OPTICAL LIGHT SOURCE.

Change step 8 of paragraph 5-3b to read:

(8) Check instrument response on "Zero Adjust," "Cal," and "step 10" of reflection check plaque. If instrument does not perform as it did prior to light-source replacement, recalibration (paragraph 5-5) may be required.

NOTE

"Zero Adjust," and "Cal" response can be checked with internal reference plaques.

2. Page 5-18. Figure 5-7.

In the uppermost view contained in figure 5-7. items ① and ② should be interchanged.

CHANGE NO. 5

DATE Jan. 4, 1972

INSTRUCTION BOOK CHANGE NOTICE

MANUAL AFFECTED RD-505 (ISSUE DATE: 7/70)

Page 1-1. Paragraph 1-4. TECHNICAL SPECIFICATIONS.

The entry for "Color Filters" should be changed to read:

Color Filters: Color filter Selector has four positions; each position is associated with a matched set of filters (see paragraph 4-2) that are recommended for general-purpose color visual response densitometry.

Selector Position	Filter Wratten No.	
Magenta	58	see figure 1-2
Yellow	47	
Cyan	25	
(W/B) Visual	106	

OWNER'S MANUAL

FOR THE

OPERATION AND MAINTENANCE

OF

RD-505

PORTABLE REFLECTION DENSITOMETER

PRICE: $5.00
ISSUE DATE:7/70

FOREWORD

This manual has been prepared to enable you to enjoy optimum performance from your new Portable Reflection Densitometer, Model RD-505. This instrument has been developed to fill the need for an easy-to-operate, portable, reliable, precision instrument for measuring the color and visual densities of materials. The information set forth in this manual will serve you over the years, and the few minutes you invest now to acquaint yourself with its contents will reap rewards for you throughout the life of your RD-505.

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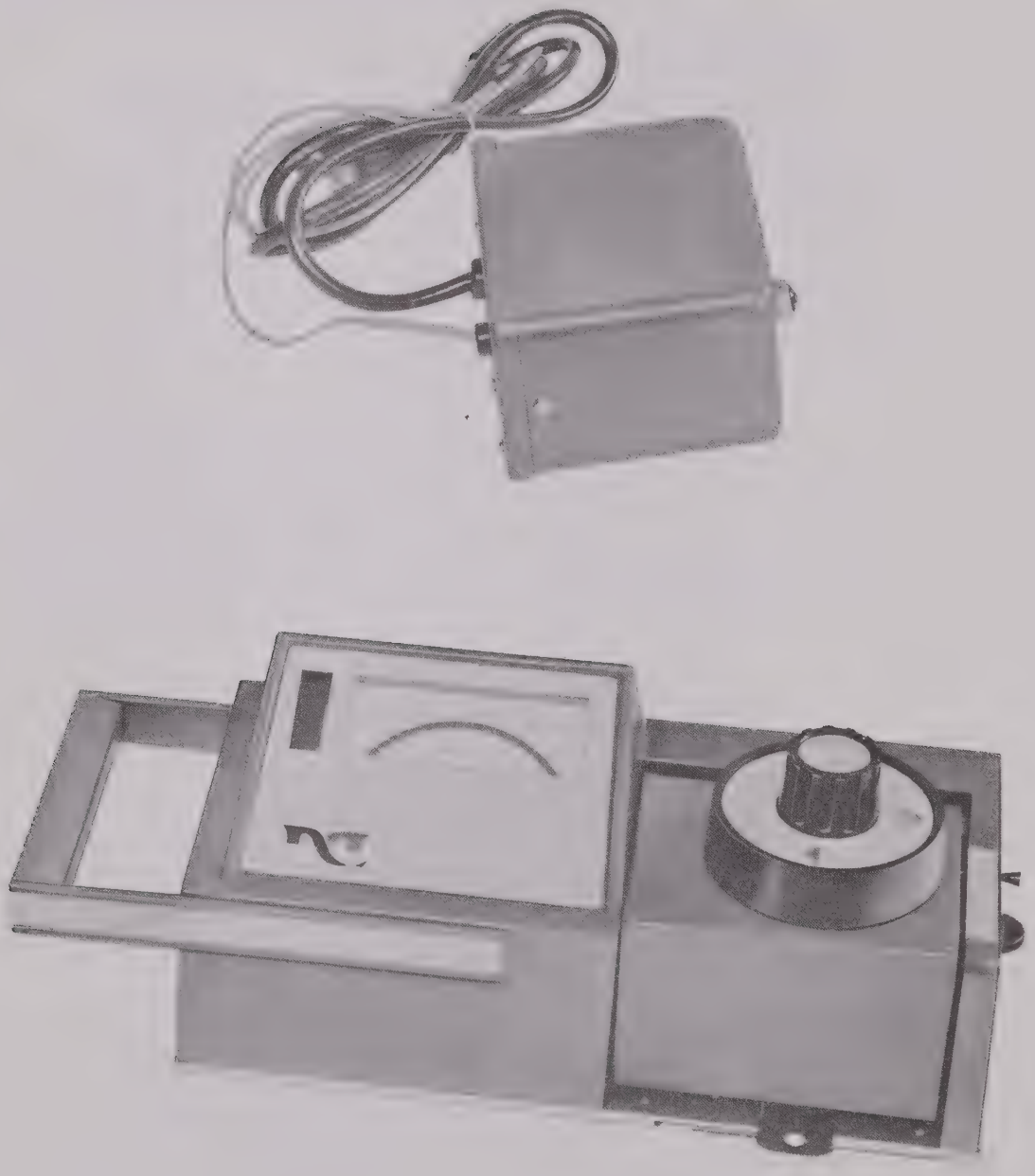


401-9

Figure 1-1. Portable Reflection Densitometer, Model RD-505

SECTION I

GENERAL INFORMATION

1-1. GENERAL DESCRIPTION

The RD-505 (figure 1-1) is an all-new, completely solid-state, portable reflection densitometer with a range of 0.0 to 2.5 density units. Additionally, the RD-505 is a dual-beam, double-detector instrument which offers the utmost in accuracy, reading repeatability, and instrument stability. Density readings are indicated on a "hybrid" system that combines digital and meter display; an output jack that facilitates patch-cord connection to a remote digital voltmeter or other recording device broadens the instrument's application possibilities. The RD-505 is battery operated by rechargeable, nickel-cadmium cells; further, the electronic design is such that the instrument can be used while the cells are being recharged. Warm-up time for the RD-505 is approximately six-tenths of a second from a "cold" state.

Electronic circuits in the RD-505 are self-compensating; in addition, thermistors are used to compensate for ambient temperature changes. Photodiodes and color filters employed in the RD-505 are enclosed in a sealed housing and are, therefore, protected against the deleterious effects of dust and dirt; this is particularly advantageous in those areas of the Graphic Arts industry wherein offset spray powder is used.

Readings taken with the RD-505 indicate ANSI diffuse reflection density, and the use of a linear meter scale in conjunction with a hybrid display system minimizes possible operator confusion. A mirrored meter scale enables the operator to make accurate and reproducible readings, since parallax errors are avoided. Scale markings are arranged so that the RD-505 may also be used as a null-balance instrument. Color filters employed in the RD-505 are in consonance with GATF recommendations (see paragraph 1-4).

1-2. APPLICATIONS

The RD-505 has application in areas where the measurement of diffuse color and visual reflection density is critical for establishing and/or insuring consistent product quality. Typical examples of such applications are: (1) close control of ink density (B/W and color) in the printing process; (2) density measurements (B/W and color) of photographic reflection material.

For information concerning special applications, write to Macbeth Corporation, Newburgh, New York 12550, requesting specific assistance. These inquiries should be directed to the attention of Technical Sales and Service.

1-3. ACCESSORIES SUPPLIED

The purchase price of your RD-505 includes the following accessories which you will find enclosed in the shipping carton.

a. One battery charger.

b. One instrument carrying case.

c. One owner's manual and warranty card.

d. Simplified operating instructions.

1-4. TECHNICAL SPECIFICATIONS

Technical specifications for the RD-505 are as follows:

a. Optical system:

Optical Geometry: Approximates ANSI Standard PH2-17-1958 for measuring diffuse reflection density since the incident radiation from the light source falls on the surface of the sample at 90°, and the collection system accepts the radiation which is reflected at all azimuth angles between 0° and 360°, at elevation angles of 45° ±5°.

Color Filters: Color filter Selector has four positions; each position is associated with a matched set of filters (see paragraph 4-2) that are recommended for general-purpose color visual response densitometry.

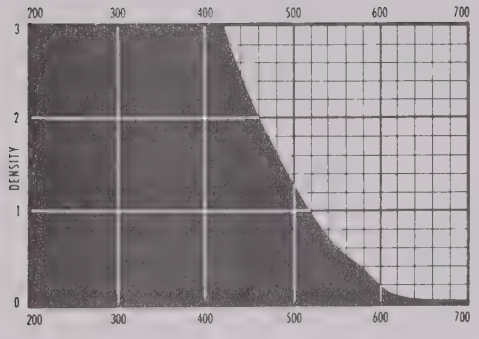
Selector Position	Filter Wratten No.	
Magenta	25	see figure 1-2
Yellow	58	
Cyan	47	
(W/B) Visual	106	

1-4. TECHNICAL SPECIFICATIONS (CONT.)

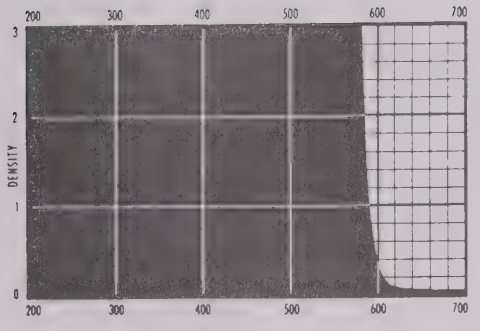
a. (Cont.)

Internal Color References	Built-in "Zero Adjust" and "Calibrate" color references represent the spectral selectivity and visual reflectance characteristics of the typical cyan, magenta, yellow, and black process-printing inks. Color chips are made of a thermosetting acrylic paint applied to an inert, sturdy aluminum base.
b. Readout:	Whole number portion of density indication is displayed via Nixie®* tube. Tenths and hundredths portion of density indication is displayed via conventional meter. Instrument readings are precise within a tolerance of ±0.02 density units; reliable readings can be made with a repeatability of ±0.01 density units. Range changing is accomplished automatically via instrument electronics; therefore reading errors due to range changing are eliminated.
c. Operating Power:	Powered by three, rechargeable, nickel-cadmium cells each having a 2.2 mpere hour capacity. Estimated cell life is approximately two years. Recharge time is approximately 10 to 12 hours. Power consumption of instrument is approximately 2.55 watts. Power consumption of battery charger is approximately 1 watt.
d. Voltage Regulation:	RD-505 contains fully-transistorized power supply with built-in comparator circuit which provides closely regulated operating voltages. Battery charger contains compensating circuitry to maintain constant charging current during normal line-voltage variations.
e. Environmental Conditions:	Operable within normal range of ambient temperature and humidity conditions. Changes in ambient illumination will not affect performance of instrument (paragraph 3-1).
f. Dimensions:	*RD-505:* 3.7 inches wide, 4.0 inches high, 8.6 inches long. *Battery Charger:* 4 1/16 inches wide, 2 5/8 inches high, 4 1/8 inches long.
g. Weight:	*RD-505:* Net Wt. = 4.0 lbs. *Battery Charger:* Net Wt. = 2 1/8 lbs.
h. Finish:	Entire instrument finished in baked, vinyl-textured, blue and gray paint.

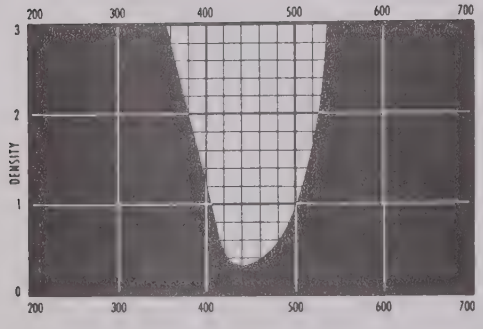
* Registered Trademark of Burroughs Corp.



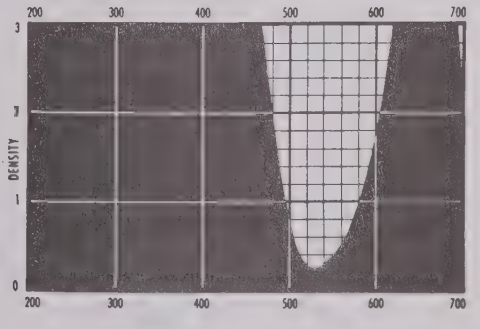
Wratten No. 106 Visual Filter



Wratten No. 25 Red Filter



Wratten No. 47 Blue Filter



Wratten No. 58 Green Filter

305-42

Figure 1-2. Transmission Characteristics, RD-505 Filters

SECTION 2

INSTALLATION

2-1. INSPECTION/FACTORY TESTING PRIOR TO SHIPMENT

Each subassembly of the RD-505 is inspected through its various stages of fabrication. After assembly, every RD-505 is operated for a period which is equivalent to a minimum of several weeks of normal service. Satisfactory completion of this operating test qualifies an instrument for final calibration and testing by our Production Department. Every instrument is then submitted to our Quality Assurance Inspectors whose acceptance guarantees our customers that each RD-505 meets the customary high performance standards of Macbeth products.

2-2. ELECTRICAL REQUIREMENTS

a. **POWER CONSUMPTION.** – Total power consumption of the RD-505 is approximately 2.55 watts. However, the instrument is battery powered; therefore, power consumption is not an installation criterion.

Total power consumption of the battery charger provided with the RD-505 is approximately 1 watt.

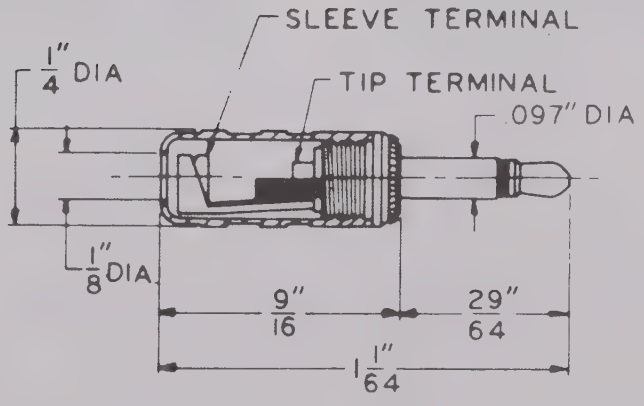
b. **OPERATING VOLTAGES.** – All instrument operating voltages are provided by a built-in, self-regulated, battery-operated power supply (see paragraph 4-3e).

The battery charger has been designed for either 115- or 230-volt operation at powerline frequencies of 50 and 60 Hz. Change from 115-volt to 230-volt operation (or vice versa) is accomplished via a clearly-marked selector switch located on the side of the battery charger.

2-3. CONNECTION TO EXTERNAL EQUIPMENT

Special jacks (BATT CHG and DVM OUT) have been provided to facilitate cable connection to: (a) a remote digital-readout device; (b) the battery charger supplied with the RD-505.

The battery charger is equipped with an input cable assembly complete with a miniature two-conductor phone plug that mates with BATT CHG jack J501. If it is necessary to fabricate an interconnecting cable to mate with DVM OUT jack J502; a two-conductor, phone plug similar to the "Micro-Plug" (mfg. by Switchcraft Corp.) should be used (see figure 2-1).



305-49

Figure 2-1. Typical Two-Conductor Micro Plug

SECTION 3

OPERATOR'S SECTION

3-1. GENERAL CONSIDERATIONS

a. **AMBIENT ILLUMINATION.** – The RD-505 is designed for operation under all normal conditions of ambient illumination. Its performance specifications (paragraph 1-4) are equally unaffected by operation in brightly-illuminated or in darkened areas; the meter scale is not illuminated, therefore some form of illumination is required when the instrument is used in dark areas.

b. **PERIODIC CALIBRATION CHECKS.** – Since the RD-505 is a manually-operated and manually-calibrated instrument; it is recommended that the ZERO ADJUST and CALIBRATION control settings be checked several times during the day, and reset whenever necessary to insure that the instrument is performing according to specifications.

3-2. CONTROLS AND INDICATORS

All operating controls for the RD-505 (with the exception of the BATT TEST switch) are located on the top of the instrument in the proximity of the Filter Selector Knob Assembly or on the Knob Assembly itself (see figure 3-1); therefore, all controls are always in full view and within easy reach of the operator. The function of each control is given in table 3-1.

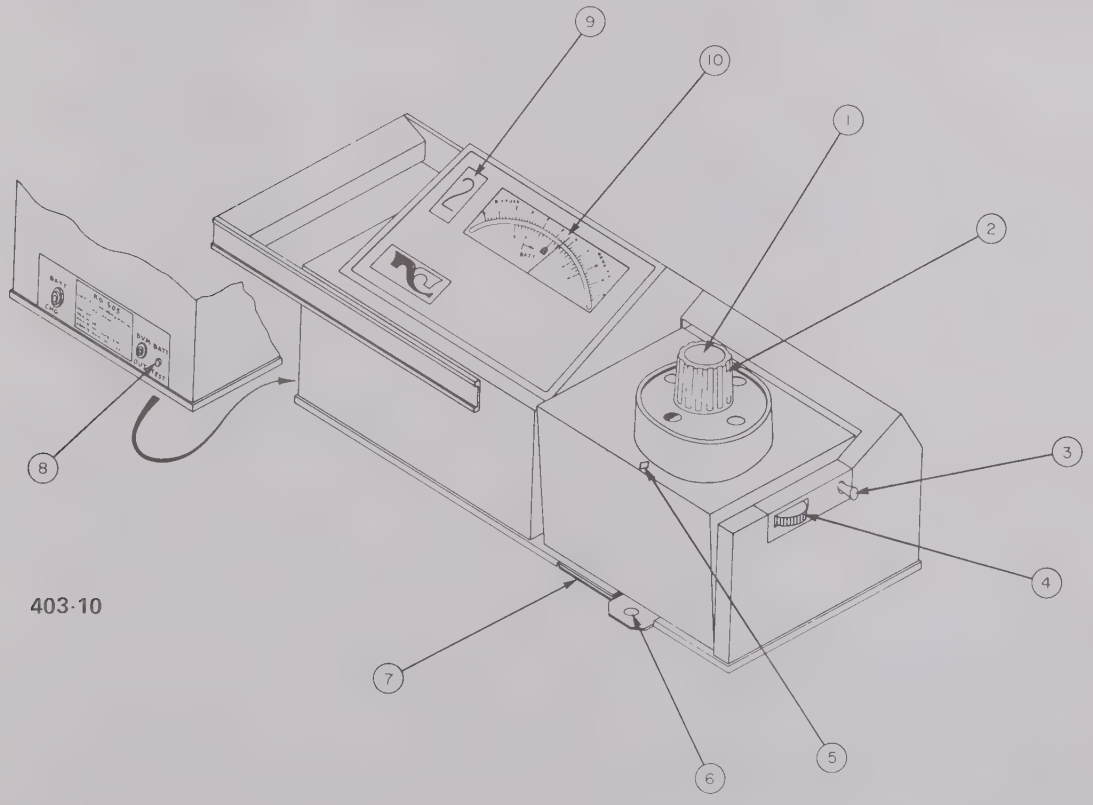


Figure 3-1. Operating Controls and Indicators, RD-505

3-3. OPERATING PROCEDURE

The RD-505 can be operated in one of two modes: (1) as a direct-reading instrument where density-value indications are desired; (2) as a null-balance instrument where deviations from a pre-set aim point serve as "go, no-go" indications.

Before attempting to operate the RD-505, the operator should first familiarize himself with the location and function of all operating controls and indicators. Refer to table 3-1 and figure 3-1, and proceed as described in paragraph 3-3a or 3-3b below.

a. **DETERMINING DENSITY VALUES.** — Proceed as follows.

NOTE

Numbers enclosed in circles are items appearing in figure 3-1.

(1) If black protective cap had been placed on Filter Selector ② after previous usage, remove protective cap. This uncovers PRESS-TO-READ switch ① which activates the unit when depressed.

CAUTION

Do not depress PRESS-TO-READ switch ① while rotating Filter Selector ② .

(2) Test battery power as outlined in paragraph 3-5.

(3) Zero Adjust RD-505 for Visual Filter Position in the following manner:

NOTE

If desired, the RD-505 may be "Zeroed" on white paper stock by placing the paper stock under the Target Aperture and adjusting the unit to read 0.00 for all filter positions. Particular attention should be paid to the following: (1) first, the instrument should be zero-adjusted and calibrated as outlined in these procedures; (2) then, only the Zero Adjust control setting should be changed.

(a) Each instrument has been zero adjusted against a calibrated standard before being shipped by the manufacturer. The zero adjust value determined by the manufacturer has been recorded on a label mounted on the Optical Housing behind the Filter Selector. Locate this label and carefully note the Zero Adjust value given.

(b) Tilt RD-505 slightly backward, reach under chassis and swing Zero-Adjust Plaque ⑦ into position over Target Aperture ⑥ . Set instrument upright.

(c) Release Transport Lock ③ by pulling it out.

(d) Rotate Filter Selector ② as required so that visual filter is in measuring position (i.e. white/black spot is aligned with Fiducial Mark ⑤).

(e) Move optical housing forward so that lamp housing is placed in contact with Zero Adjust Plaque (i.e. in measuring position).

(f) While depressing PRESS-TO-READ switch ①, press Idler Wheel ④ inwards toward instrument housing and rotate Idler Wheel as required to obtain indication on meter ⑩ corresponding to "Zero Adjust" value mentioned in step (a) above ("O" filament of Nixie tube will glow). Release Idler Wheel and PRESS-TO-READ switch; return Zero Adjust Plaque ⑦ to its storage position.

(4) With visual filter in position, calibrate instrument for high-density value as outlined below. Proper "Calibration" values for each filter position are recorded on the same label as "Zero Adjust" values used in step (f) above.

NOTE

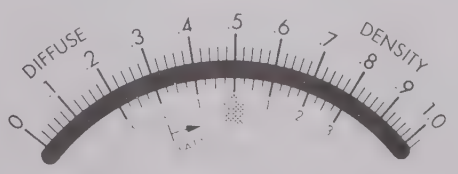
A Color Reference Plaque containing black, cyan, magenta, and yellow color chips is supplied with the instrument and is mounted within the instrument housing. This Color Reference Plaque is mechanically linked to the Filter Selector ② so that the appropriate color chip (for the filter being used) is automatically placed in "calibrate" position. In accordance with operational requirements, the user can replace the Color Reference Plaque with a plaque containing color chips of his own choice (refer to paragraph 3-4).

(a) Move optical housing to rearward position.

CAUTION

When performing step b below, ensure that optical housing is not firmly seated in rearward position while Filter Selector is being rotated. Otherwise the Color Reference plaque may bind against the lamp housing.

TABLE 3-1. OPERATING CONTROLS AND INDICATORS

ITEM NO. (Fig. 3-1)	CONTROL/INDICATOR DESIGNATION	FUNCTION
1	PRESS-TO-READ (Switch SW501)	When depressed, positive (+) side of battery pack is connected to power supply and instrument is energized. When released, positive side of battery pack is disconnected.
2	Filter Selector	Rotation of Selector places desired filter in path of light flux falling upon photodiode.
3	Transport Lock	Locks optical housing in its rearward position when pushed inwards.
4	Idler Wheel	When pressed inward, rotation of idler wheel adjusts Zero Adjust or Calibrate potentiometer for filter being used. If optical housing is in forward position, Zero Adjust potentiometer is adjusted. If optical housing is in rearward position, Calibrate potentiometer is adjusted.
5	Fiducial Mark	Reference point to indicate which filter is interposed in optical light beam.
6	Target Aperture	Isolates area of sample being measured.
7	Zero Adjust Plaque	Provides a Zero Adjust reference when swung into position over Target Aperture (item 6).
8	BATT TEST (Switch SW502)	Pushbutton switch. When depressed simultaneously with PRESS-TO-READ switch (item 1), the Hybrid Display Stage is connected across the power supply and the battery output voltage is displayed on Meter M501. When released, the Hybrid Display Stage is connected across the output of the Log Converter and Subtraction Amplifier stages and sample density indications are displayed on the digital voltmeter and on meter M501.
9	Nixie Tube	Displays whole-number portion (i.e. "0", "1", or "2") of density indication.
10	METER M501	Upper scale displays decimal portion of density indication. Note that complete density readings are obtained by combining indications on meter M501 and on the Nixie tube. Lower scale is used when RD-505 is used as a null-balance instrument. In this case, digital indications should be ignored. Indications to right of center null point denote that sample being measured is darker than sample to which RD-505 is indexed; indications to left indicate that sample is lighter (refer also to paragraph 3-3b). BATT indication on meter face is for battery test purposes (paragraph 3-5). 

(b) While depressing PRESS-TO-READ switch ①, press Idler Wheel ④ inwards toward instrument housing and rotate Idler Wheel as required to obtain density indication (i.e. display on Nixie tube ⑨ plus meter ⑩ indication) corresponding to "Calibration" value recorded on label mounted on the instrument. Release Idler Wheel and PRESS-TO-READ Switch.

(5) Repeat steps 3 and 4 above for each of remaining filter positions (i.e. yellow, magenta, and cyan). Notice that the Zero Adjust value for each filter is the same whereas the Calibration value for each filter is different.

(6) Position Target Aperture ⑥ over sample to be measured. Rotate Filter Selector to desired filter position (see table 3-2). Move optical housing forward into measuring position, depress PRESS-TO-READ switch ① and read measured density on Nixie tube and meter combination.

b. **NULL-BALANCE OPERATION.** – In some situations, working with deviations from a pre-set aim point (i.e. comparative information) is more desirable than working with density units. Control of ink density at the delivery end of a press is typical of such a situation; once the desired tolerances are established, the RD-505 may be used as a "go, no-go" indicator. For null-balance operation, proceed as follows.

NOTE

Numbers enclosed in circles are items contained in figure 3-1.

(1) Perform steps 1 through 5 inclusive of paragraph 3-3a.

(2) Position Target Aperture ⑥ over approved color sample (i.e. color sample to be used as standard). Rotate Filter Selector ② to desired filter position (see table 3-2); move optical housing forward into measuring position. While depressing PRESS-TO-READ switch ①, press Idler Wheel ④ inwards toward instrument housing and rotate Idler Wheel as required until meter ⑩ pointer is centered within Null area (▒) of lower scale.

(3) Repeat step 2 above for each of three remaining possible color samples to be used as standards.

(4) Comparison between subsequent copies (e.g. production run copies) and color standards established/selected in steps 2 and 3 above can now be made as follows. Place Target Aperture over color sample being measured. Rotate Filter Selector to desired filter position, and move optical housing forward into measuring position. Depress PRESS-TO-READ ① switch and note indication on meter. Indications to left of Null area indicate that sample is lighter than standard, whereas indications to right of Null area indicate that sample is darker. Individual experience will establish acceptable limits of "light" and "dark."

3-4. CHANGING INTERNAL COLOR STANDARDS/REFERENCES

The color chips contained in the reference plaque supplied with the instrument represent the spectral selectivity and visual reflectance characteristics of the typical cyan, magenta, yellow, and black process-printing inks. In some instances (e.g. where actual process inks used vary in appearance the color chips in the Macbeth Reference Plaque), it may be advantageous to calibrate the instrument on a color sample of the job itself. Once a color sample has been selected and approved, it can be mounted on a blank Reference Plaque Subassembly (i.e. standards holder – see Parts List) in the following manner.

NOTE

To facilitate this task, a special kit containing hardware, standards holder, adhesives, and instructions may be purchased from the Macbeth Corporation.

TABLE 3-2. COLOR SAMPLE VS. FILTER

Color Sample Being Measured	Filter Selector Position	Filter	
		Color	Wratten No.
Black/White	Black/White	Amber (Visual Response)	106
Process Blue (Cyan)	Process Blue (Cyan)	Red	25
Process Red (Magenta)	Process Red (Magenta)	Green	58
Yellow	Yellow	Blue	47

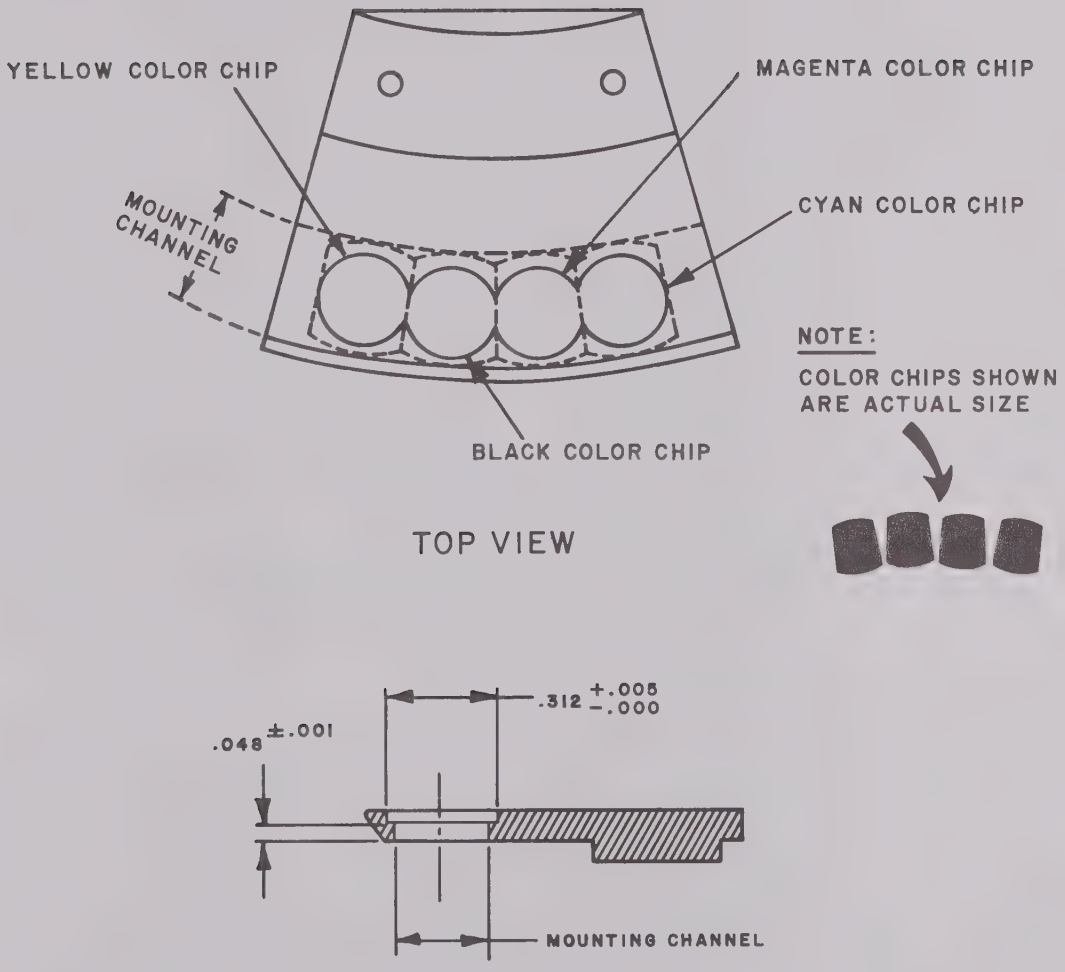


Figure 3-2. Reference Plaque Subassembly, RD-505

a. Using procedure outlined in paragraph 3-3a, carefully determine and note density value/s of color sample/s to be mounted on standards holder and used as internal reference/s.

b. Cut piece/s of color sample/s to size and shape of color chips shown in figure 3-2.

CAUTION

When performing step c and d below, care must be exercised to use a base material and an adhesive that will not alter the spectral reflectance characteristics of the color sample.

c. Using dimensions shown in figure 3-2 for "mounting channel," cut piece of material to be used as base for mounting color chip/s made in step a above. Note also that base material should have same spectral characteristics as stock on which color chips (i.e. new standards/references) were printed. Particular attention should be paid to the fact that the combined thickness of both the color chips and the mounting base must be less than .048 inch.

d. Using clear double-sided adhesive tape or other suitable adhesive, mount color chips in proper position (see figure 3-2) on mounting base made in step c above.

e. Using glue or other suitable adhesive (see CAUTION above) secure mounting base with color chips to blank standards holder. Take care that color chips are kept free of glue smudges, fingerprints, dirt and/or any other element that may alter their spectral characteristics.

f. Rotate Filter Selector ② of RD-505 as required so that visual filter is in measuring position. Tilt instrument slightly backwards; remove access plate (see figure 5-1); Reference Plaque subassembly should fall free of Standards Selector and of instrument when instrument is returned to upright position.

g. Install new Reference Plaque subassembly in Standards Selector; replace access plate and return instrument to service. When in use, the RD-505 should be calibrated to the density values noted in step a of this procedure.

3-5. BATTERY TEST

The RD-505 employs three, rechargeable, nickel-cadmium cells each having a 2.2 ampere-hour capacity. If these cells are maintained in a proper state of charge their estimated life is approximately two years under normal usage. To ascertain the charge/discharge condition of the cells, simply depress both the BATT TEST switch (8, figure 3-1) and the PRESS-TO-READ switch (1, figure 3-1) simultaneously and note the meter indication. If the meter indication is to the left of "BATT," the cells need to be recharged (refer to paragraph 5-1d).

SECTION 4

INSTRUMENT ANALYSES

4-1. FUNCTIONAL ANALYSIS (Refer to Figure 4-1)

The RD-505 comprises four basic sections: an Optical system; a Log Converter and Subtraction Amplifier Stage; a Hybrid Display Stage; and a Power Supply. A battery charger is also provided with the RD-505 as an auxiliary unit.

Operation of the RD-505 circuitry is based upon the use of a dual-beam, double detection system that utilizes two photodiodes to compare the amount of energy originating at the optical light source with the amount of energy (from the same source) that is reflected from a sample being measured. The difference in current output of both photodiodes is then converted to a voltage that is proportional to the logarithm of the difference current. This voltage is then used as a measure of the optical density of the sample being measured.

In the RD-505, radiant energy from the optical light source (L501) is applied to each of two photodiodes (V501 and V502) as follows:

a. In consonance with existing standards for diffuse reflection density (paragraph 4-2), an imaging lens in lamp L501 focuses the radiant energy (i.e. measuring beam) on the sample; energy reflected from the sample is collected, filtered, and impinged on the cathode of V501.

b. A sample of the radiant energy (i.e. reference beam) from L501 is piped via fiber-optic cable to a chamber where it is filtered and then impinged on the cathode of V502.

Photodiodes V501 and V502 are operated at a fixed voltage and each produces a current that is directly proportional to the amount of light energy striking its respective cathode. Since there is no sample interposed in the reference light beam, the difference in output of V501 and V502 is attributable to and directly proportional to the reflectance of the sample interposed in the measuring light beam.

The output current of each photodiode is applied as an input signal to Log Converter Q203A and Q203B. Certain inherent characteristics of bipolar transistors make it possible to derive output voltages from Q203A and Q203B that vary directly as the logarithm of input current; these outputs, therefore, are (by definition) a measure of optical density.

The outputs of both Log Converters are combined within Subtraction Amplifier Q303, and the difference between both signals is amplified by a factor of 16.6 (the gain of Q303) to produce a signal that corresponds to optical density on a one-volt/one-density basis.

The output signals from Subtraction Amplifier Q303 are applied simultaneously to: (1) two stages of level detection (Q106 and Q107); (2) a Controlled Current Sink (Q108A, Q108B, Q112 and Q113); (3) and Meter M501. When the output of amplifier Q303 is within the 0.00 to 1.03 vdc range, Level Detectors Q106 and Q107 are de-energized, transistor Q109 in the Nixie Drive circuit is energized ("0" filament of Nixie tube glows), the Controlled Current Sink remains de-energized and the entire output is felt by Meter M501. When the output of amplifier Q303 is between 1.03 and 2.03 vdc, Level Detector Q106 is energized, transistor Q110 in the Nixie Drive circuit is energized ("1" filament of Nixie tube glows), transistor Q112 of the Controlled Current Sink is energized and only that portion of the output above 1.03 vdc is felt by Meter M501. When the output of amplifier Q303 is between 2.03 and 3.03 vdc, Level Detectors Q106 and Q107 are both energized, transistor Q111 in the Nixie Drive circuit is energized ("2" filament of Nixie tube glows), transistors Q112 and Q113 of the Controlled Current Sink are both energized, and only that portion of the output above 2.03 vdc is felt by Meter M501.

4-2. OPTICAL SYSTEM, DETAILED ANALYSES, (Refer to Figure 4-2).

The Imaging and Collection Optics of the RD-505 approximate the geometric specifications set forth by the American National Standards Institute in PH2. 17-1958 for the measurement of diffuse reflection density. Light from the optical system light source (lamp L501) is focused by an imaging lens (part of L501) and directed at a 90° angle incident to the plane of the sample. Light reflected from the sample at 45° $\pm$5°, through a 360° cone, is collected and reflected by an annular ring through an IR rejection filter and a measuring color filter onto the cathode of photodiode V501. A sample of the light flux from lamp L501 is piped through a noncoherent, fiber-optic cable, to the cathode of photodiode V502. The current outputs of V501 and V502 (see table 4-1) are then compared and converted to density indications (paragraphs 4-3b through 4-3d).

The optical housing is hinged (i.e. linked) to the main housing in such a way (see figure 4-2) that the Imaging and Collection Optics System can be placed in one of two positions: (1) in the forward position, the measuring snout (i.e. lamp housing) is placed over the sample being measured; (2) in the rearward position, the measuring snout is placed over one of four built-in, interchangeable, color chips for calibration purposes (paragraphs 3-3 and 5-5).

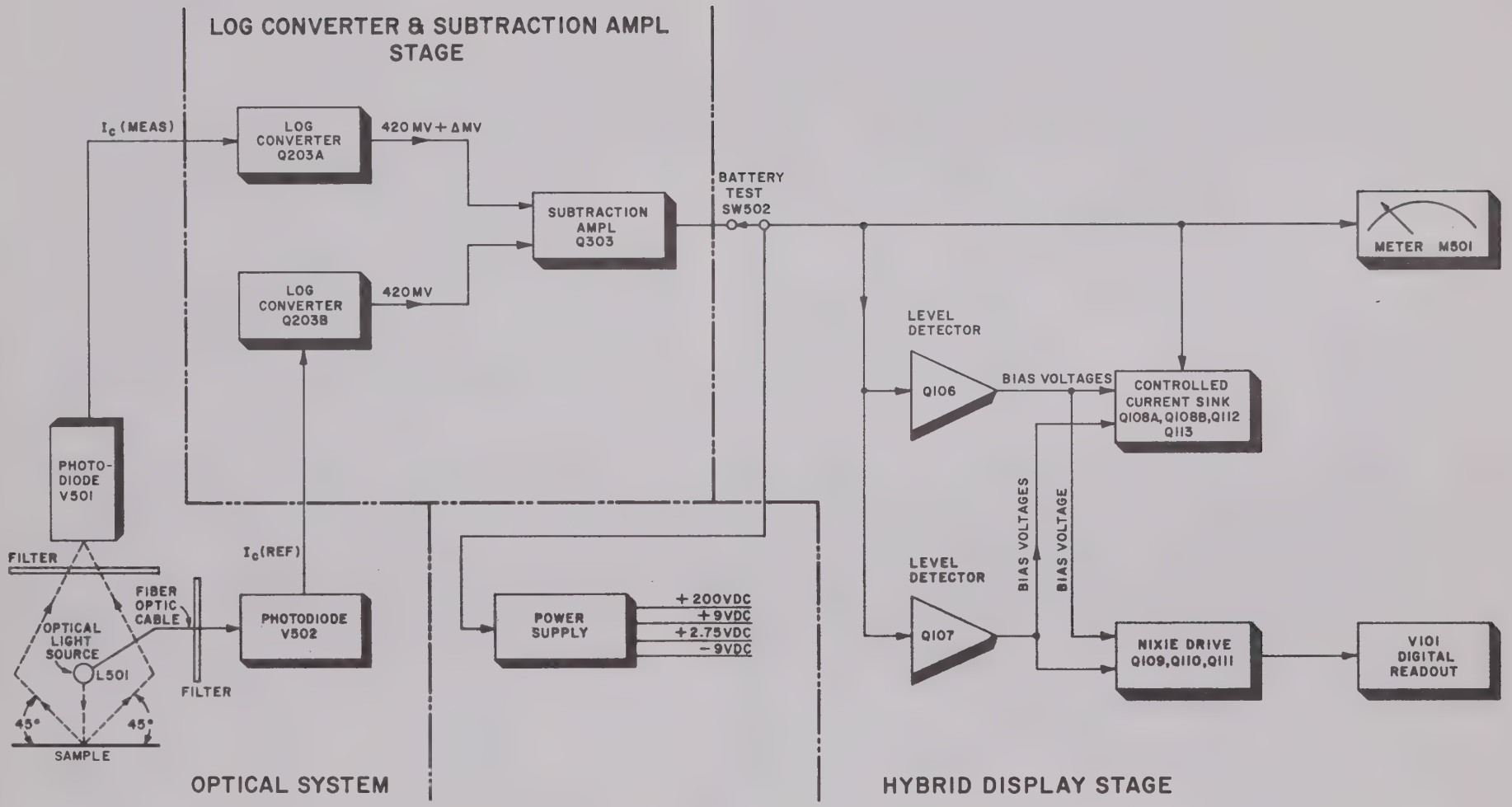


Figure 4-1. Functional Block Diagram, RD-505

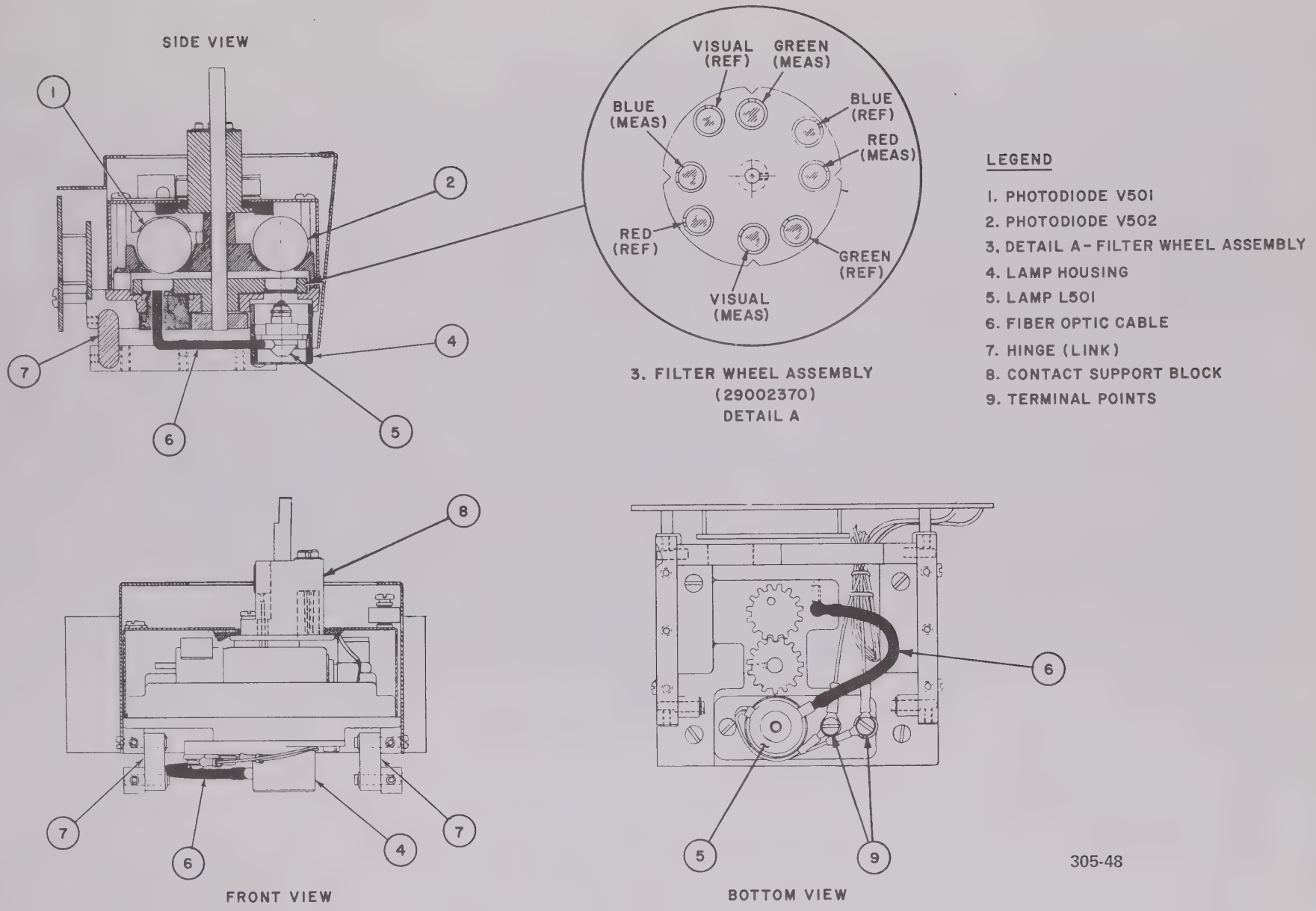


Figure 4-2. Optical System, Pictorial Diagram, RD-505

A filter wheel assembly (detail A, figure 4-2) in the optical housing contains four sets of matched filters (i.e. two filters per set, for a total of eight — see also paragraph 1-4). Each filter of a set is positioned so that when one filter is interposed in the path of the measuring light beam, the corresponding matched filter is interposed in the path of the reference light beam (refer also to paragraph 4-3a). A rotatable knob assembly (item 2, figure 3-1) enables the operator to select (i.e. "dial in") the desired color filter. The zero adjust and up-scale calibration for each filter position is accomplished electronically (paragraph 4-3c) by the idler-driven, switch-selectable, potentiometers located in the knob assembly.

4-3. ELECTRONIC CIRCUITS, DETAILED ANALYSES

a. **PHOTODIODES.** — A photodiode consists of two elements, a photoelectric emitter (or cathode) and a positive current-collecting anode, enclosed within an evacuated (or gas-filled) glass envelope. Unlike a photomultiplier tube, a photodiode does not contain a dynode structure and hence no multiplication action takes place within the tube. The gain of a photodiode is fixed and cannot be changed with applied voltage as is the case with a photomultiplier tube. Further, the output current of a photodiode is extremely small; for example, a typical output current of the photodiode employed in the RD-505 is 1/100th of a micro-amp.

The various cathode-surface materials employed in photodiodes respond differently to light energy; for example, some cathode surfaces are good emitters for red light whereas other cathode surfaces are more sensitive to light energy of a different wavelength. Photodiodes contained in the RD-505 employ a cathode-surface material that has a typical S-4 response; maximum emission occurs between 400nm and 500nm.

The RD-505 contains two photodiodes: (1) one photodiode (V501) reacts to the changes in light intensity that occur as a result of different samples being measured, and its output is applied to Log Converter Q203A; (2) the other photodiode (V502) reacts, via fiberoptic cable, to the light intensity of Optical Light Source L501, and its output is applied to Log Converter Q203B. As described in paragraph 4-3c, density indications are obtained by comparing the outputs of both Log Converter stages. By using the intensity of lamp L501 as a reference, density indications are automatically corrected as the output of L501 changes due to warm-up or aging.

b. **LOG CONVERTER STAGES, CIRCUIT ANALYSIS** (Refer to Figures 4-1 and 7-1). — The RD-505 is a dual-beam instrument and consequently contains two separate Log Converter stages comprising: (1) bipolar transistor Q203A, field-effect transistor Q201A/B, an inverting operational amplifier (Q301), thermistor R201, and associated circuitry; (2) bipolar transistor Q203B, field-effect transistor Q202A/B, thermistor R202, and associated circuitry. Within the Log Converter stages, the output current of each photodiode (V501 and V502) is converted to a voltage that is proportional to the logarithm of light energy impinged on the photocathodes of V501 and V502. The output signal from each Log Converter stage is applied (via resistors R305 and R317 or R308 and R318) to the Subtraction Amplifier (paragraph 4-3c). The prime difference between the two Log Converter stages is that one is associated with the measuring light beam and the other is associated with the reference light beam (refer to paragraph 4-3a); both stages function in a similar manner, therefore, only the stage associated with the measuring light beam will be discussed in the remainder of this paragraph.

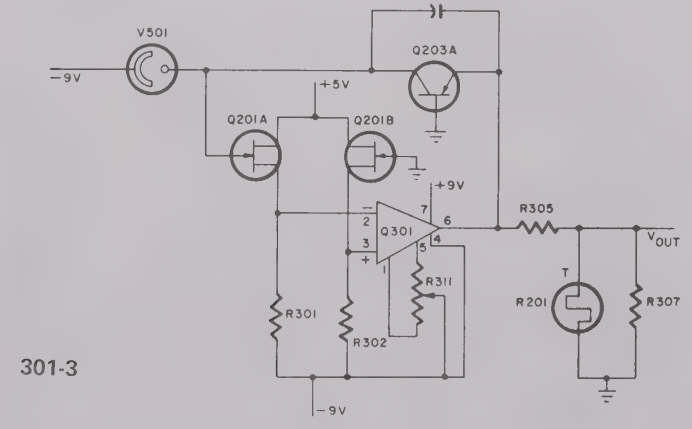


Figure 4-3. Log Converters, Schematic Diagram

Operation of the Log Converter stages is based upon the phenomenon that the base/emitter voltage V_{BE} of a bipolar transistor will vary as the log of collector current (I_C) if the collector and base of the transistor are held at the same potential. This equipotential condition is achieved in the Log Converter Stage via the basic configuration shown in figure 4-3. Since operational amplifier Q301 maintains both its inputs at the same potential, the base and collector of transistor Q203A remain at the same potential (i.e. ground) and the base/emitter output voltage (V_{BE}) of Q203A varies as the log of collector current (I_C); note that the collector current of Q203A is also the output current of photodiode V501. Since the output current of V501 varies directly as the transmittance of the sample being measured (paragraph 4-1), it follows that: (1) the input to Q203A varies directly as sample transmittance; (2) the output of Q203A varies directly as the log of sample transmittance; (3) the output of Q203A varies directly as optical density of the sample being measured. As can be seen in table 4-1, there is a change of 60 mv in the output of Q203A for each 1-density change in the sample being measured.

As mentioned in paragraph 4-2, the output current of a photodiode is extremely weak; with reference to the Log Converter circuits, it is important that all of this current flows in the collector circuit of the bipolar transistor and not in the negative (-) input circuit of the operational amplifier. Since the input current requirements of the operational amplifiers exceed the amount of current available from the photodiodes, a buffer-amplifier stage is required. For this reason, transistor Q201, a dual, field-effect transistor, is employed as an impedance-matching amplifier that isolates the input of operational amplifier Q301 from the collector circuit of transistor Q203A (refer to figure 4-3). The gate current required by Q201 is only 3 pico amps, a small fraction of the current available from photodiode V501. Use of a dual, field-effect transistor (Q201A/B) reduces any drift (due to temperature) that may occur under normal usage.

Resistors R305 and R307 in conjunction with thermister R201 form a temperature-compensating network (see figure 4-3) that reduces the effect of the inherent "negative temperature coefficient of resistance" (i.e. emitter/base junction resistance varies indirectly as temperature changes) of transistor Q203. Without a compensating network, this phenomenon could cause the RD-505 to display a .01D drift for a 15° change in temperature. As temperature increases, the resistance of R201 decreases thus changing the voltage-divider ratio of R305, R307 and R201. This change compensates for the increasing gain of transistor Q203 with temperature.

Potentiometer R311 adjusts the input voltage to transistor Q203A; this voltage must be less than 1 millivolt. Capacitor C201 reduces noise and prevents oscillation thus insuring that the Log Converter circuit will be stable for all values of collector current in Q203A.

c. **SUBTRACTION AMPLIFIER STAGE, CIRCUIT ANALYSIS** (Refer to Figures 4-1, 4-4, and 7-1). — The Subtraction Amplifier stage comprises an operational amplifier (Q303), Zero Adjust potentiometers R401 through R404, Calibrate potentiometers R405 through R408, Thermistor R325, and associated circuitry. Within the Subtraction Amplifier stage, the output signals from both Log Converter stages (paragraph 4-3b) are compared, and the difference between the two signals is then amplified and applied simultane-

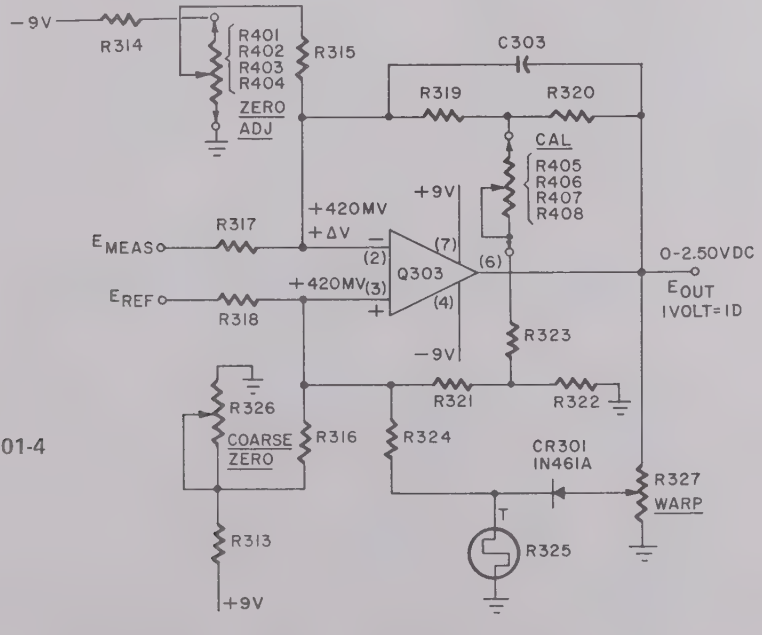


Figure 4-4. Subtraction Amplifier, Schematic Diagram

ously to: (1) Level Detectors (paragraph 4-3d); (2) Logic Switching circuits (paragraph 4-3e); (3) metering circuit (paragraph 4-3f).

As sample density increases or decreases, there is a corresponding increase or decrease in the output voltage of Log Converter Q203A (refer to paragraph 4-3b). This voltage is applied as one of the input signals (nominally 420mv at 0 density) to Subtraction Amplifier Q303. The other input signal (nominally 420mv at all densities) is the output voltage of Log Converter Q203B. Amplifier Q303 sees a 60mv difference in the input signals for each change of one density (see table 4-1) in the sample being measured. This difference is amplified by a factor of 16.6 (i.e. the gain of Q303) thus producing an output signal within the range of 0.0 to 2.5 vdc and which corresponds to sample density.

The gain (nominally 16.6) of Subtraction Amplifier Q303 is determined by the series-parallel feedback circuit (i.e. degenerative feedback) comprising resistors R319, R320, R322, R323, and CALIBRATE potentiometer R405, R406, R407, or R408. Note that there is a CALIBRATE potentiometer for each of four "reference" filter positions (see table 4-2 and figures 4-2 and 5-8). Potentiometers R405 through R408 are switch-selectable, idler-driven controls (refer to Section 3 of this manual) that are used to increase or decrease the total resistance of the feedback path and thus vary the gain of amplifier Q303 by approximately ±15 percent for calibration purposes.

Additional gain is employed in the Q303 stage at higher density readings (i.e. 2.0 density and above) to offset the effects of stray light. Potentiometer R327, diode CR301, thermistor R325, and resistor R324 form a regenerative feedback circuit wherein potentiometer R327 determines the forward bias of diode CR301. When the output voltage of Subtraction Amplifier Q303 reaches 2.0 volts (i.e. output voltage at 2.0 density), CR301 begins conducting, and a portion of the output voltage is applied via resistor R324 to the positive (+) input of amplifier Q303. Thermistor R325 compensates for the temperature characteristics of diode CR301.

In addition to a CALIBRATE potentiometer there is a ZERO ADJUST potentiometer (R401, R402, R403, or R404) associated with each "measuring" filter position (see table 4-2 and figures 4-2 and 5-8). In conjunction with resistor R314, each of these potentiometers forms a voltage divider network whose output voltage is applied (via resistor R315) to the negative (−) input of Subtraction Amplifier Q303. When the ZERO ADJUST potentiometer is adjusted, the voltage at the junction of R314 and R315 is changed, there is a corresponding change in current flow through R315, and the negative (−) input of amplifier Q303 is driven accordingly. Basically, potentiometer R326 and resistor R316 form a voltage divider that performs the same function at the positive (+) input of amplifier Q303. Potentiometer R326, however, is used to adjust for differences in absolute light levels between the reference light beam and the measuring light beam.

Bypass capacitor C303, shunting resistors R319 and R320, provides a reduction in noise and also causes amplifier Q303 to be stable for all values of gain and input voltage.

d. **HYBRID DISPLAY STAGE, CIRCUIT ANALYSIS** (Refer to Figures 4-1 and 7-1). — The Hybrid Display Stage comprises four sections: (1) two Level Detectors (operational amplifiers Q106 and Q107 configured as Schmitt Triggers); (2) a Nixie Drive Circuit (transistors Q109 through Q111 and diodes Q108C and Q108D); (3) a Controlled Current Sink (transistors Q108A, Q108B, Q108E, Q112, and Q113); (4) Meter M501. Incoming signals to the Hybrid Display Stage are applied simultaneously to the Current Sink, the Meter, and the Level Detectors. The switching action of Level Detectors Q106 and Q107 triggers (i.e. controls) the Nixie Drive Circuit and the Controlled Current Sink which in turn determine the digital display and control the amount of current flow through meter M501.

A sample of the input signal (d-c voltage) from the Subtraction Amplifier (paragraph 4-3c) is applied to the

TABLE 4-1. MEASURING BEAM VS. REFERENCE BEAM, PHOTODIODE AND SUBTRACTION AMPLIFIER OUTPUTS AT VARIOUS DENSITIES

DENSITY	OUTPUT			
	V501	V502	Q203A	Q203B
0	500na	500na	420mv	420mv
.5	158na	500na	390mv	420mv
1.0	50na	500na	360mv	420mv
1.5	15.8na	500na	330mv	420mv
2.0	5na.	500na	300mv	420mv
2.5	1.58na	500na	270mv	420mv

inverting (–) input of amplifiers Q106 and Q107 whereas a reference signal within the +.03 vdc to –.03 vdc range is applied to the non-inverting (+) inputs (see figure 4-5). When the inverting input signal for amplifiers Q106 and Q107 is more positive than the reference signal at the non-inverting input, the output of one or both amplifiers is saturated near -8.5 vdc (see table 4-3). On the other hand, when the inverting input signal is more negative than either of the non-inverting inputs, the output of both amplifiers is saturated near +8.5 vdc. Switching action for each amplifier takes place when the signal at its inverting input terminal reaches +.03 vdc. Resistors R113 and R114 are selected so that the voltage at the inverting terminal of Q106 reaches +.03 vdc when the input voltage is +1.03 vdc. Similarly, resistors R115 and R116 are selected so that the voltage at the inverting input of Q107 reaches +.03 vdc when the input voltage is 2.03 vdc.

When the input voltage to the Hybrid Display Stage is between 0.00v and +1.03v, the output of both Level Detectors is +8.5 vdc and the following circuit conditions exist:

(1) the voltage at point A (figure 4-5) and point B is +5v and +0.6v respectively; transistors Q112 and Q113 are reverse biased thus disabling the Current Sink (Q108A and Q108B). The total current flowing through resistor R117 appears on meter M501. Resistor R117 is selected such that 1.0v causes 100 microamps to flow in the meter, resulting in a full-scale deflection.

(2) the voltage at point C is + 1.8v; transistor Q109 is forward biased and its collector-emitter current causes the "0" cathode of the Nixie tube to glow. This same voltage reverse biases transistor Q110 and it is non-conducting.

(3) the voltage at point D is +0.9v and is applied as reverse bias to the emitter of transistor Q111, and Q111 is non-conducting.

When the input voltage to the Hybrid Display Stage is between +1.03 and +2.03v, the outputs of Level Detectors Q106 and Q107 are –8.5 vdc and +8.5 vdc respectively, and the following circuit conditions exist:

(1) the voltage at point A is now approximately –5v; transistor Q112 is thus forward biased and its collector-to-emitter current through resistors R126 and R124 forward biases transistors Q108B and Q108A and results in a current flow of 100 microamperes in the collector-to-emitter circuit of transistor Q108B. Since transistor Q108B and Q108A are integrated-circuit transistors that are mounted side-by-side on the same chip and because of the configuration used, the collector current of Q108A is equal to the collector current of Q108B (within approximately ½ of one percent). Collector-to-emitter current flow of Q108A shunts 100 microamperes from the meter (M501) maintaining the meter in an on-scale condition.

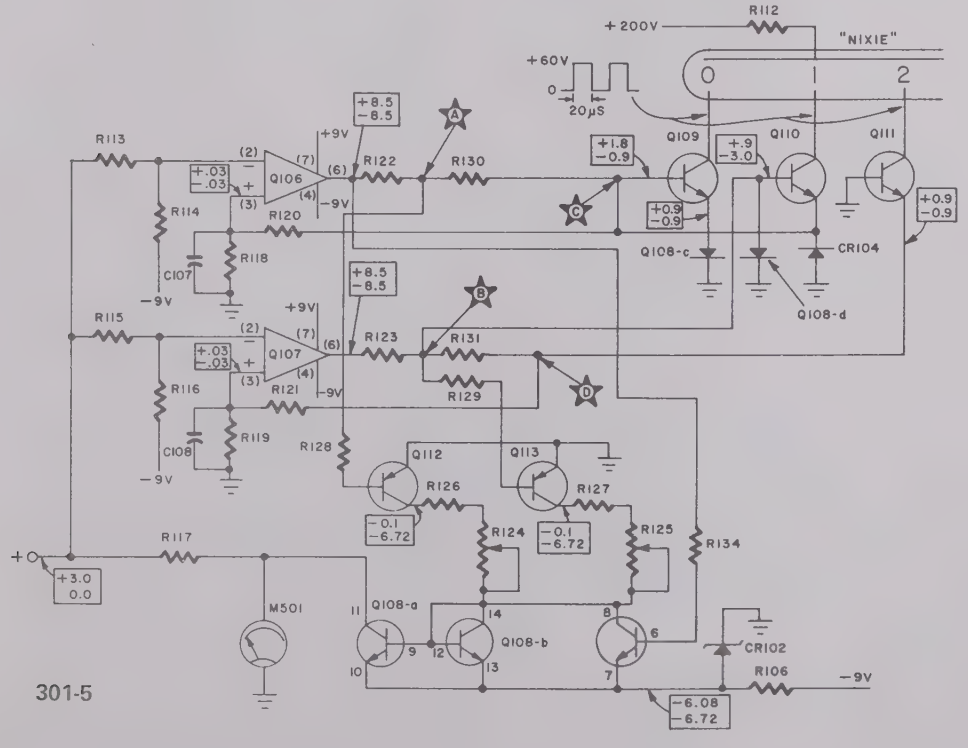


Figure 4-5. Hybrid Display, Schematic Diagram

TABLE 4-2. FILTER POSITION VS. CALIBRATE/ZERO ADJUST POTENTIOMETER

FILTER POSITION*	POTENTIOMETERS*	
	CALIBRATE	ZERO ADJUST
Magenta	R405	R401
Yellow	R406	R402
Visual	R407	R403
Cyan	R408	R404
*Potentiometers have been arbitrarily assigned to filter positions for purposes of circuit analyses.		

(2) the voltage at point C switches from +1.8 to approximately –0.9v; the base of transistor Q109 is driven negative and Q109 is reverse biased, the emitter of Q110 is driven negative causing Q110 to conduct. The collector-to-emitter current of Q110 causes the "1" cathode of the Nixie tube to glow.

(3) since the output of Level Detector Q107 is the same as it was previously, transistor Q111 remains in a non-conductive state. The voltage at point B remains as it was, therefore, transistor Q113 remains reverse biased and is non-conducting.

When the input voltage to the Hybrid Display Stage is between +2.03v and +3.0v, the outputs of both Level Detectors (Q106 and Q107) are approximately –8.5 vdc, and the following circuit conditions exist:

(1) the voltages at point A and point B are approximately –5v. Transistors Q112 and Q113 are forwarded biased and their collector-to-emitter current through resistors R126, R124, R127, and R125 forward biases transistors Q108B and Q108A. The collector-to-emitter current of Q108B and Q108A is 200 microamperes and it is this amount that is shunted from the meter (M501), thus maintaining the meter in an on-scale condition.

(2) the –5v at point B is also applied as reverse bias to the base of transistor Q110, which is cutoff. The voltage at point D (approximately –0.9v) is applied as emitter drive to transistor Q111, and collector-to-emitter current of Q111 causes the "2" cathode of the Nixie tube to glow.

Although the switching action of Level Detectors Q106 and Q107 is sequential, it is instantaneous and indiscernable to the human eye when input voltages in the higher ranges (i.e. 1.03v to 2.03v and 2.03v to 3.0v) are applied.

To prevent instability at the switching points of Level Detectors Q106 and Q107, resistors R118, R120, R119, and R121 are configured to provide hysteresis. For example, when the output of Level Detector Q106 is at +8.5 vdc, point C is at +1.8v and the voltage at the junction of R118 and R120 is approximately +30 millivolts. When the output at point C switches to –.9v, the voltage at the junction of R118 and R120 changes to approximately –15 millivolts. This changes the switching point of Level Detector Q106 approximately 45 millivolts. Hysteresis for Level Detector Q107 is determined by resistors R119 and R121 and functions in exactly the same manner as the hysteresis for Level Detector Q106.

It should be noted that proper operation of the Hybrid Display Stage requires a highly-regulated negative reference voltage (–9 vdc ±15 mv). This is provided by a

TABLE 4-3. OUTPUT VOLTAGES, SUBTRACTION AMPLIFIER VS. LEVEL DETECTORS

OUTPUT SIGNAL from SUBTRACTION AMPL.	OUTPUT (APPROX.)	
	Q106	Q107
0 - 1.03 vdc	+8.5 vdc	+8.5 vdc
1.03 - 2.03 vdc	–8.5 vdc	+8.5 vdc
2.03 - 3.03 vdc	–8.5 vdc	–8.5 vdc

temperature compensated Zener Diode (CR102), operated from a regulated supply. The –9 vdc from this supply is used as the return for the voltage dividers R113, R114, R115, and R116 that control the switching points of the Level Detectors. The highly-regulated voltage from the Zener Diode is –6.2 volts ±5%.

e. **POWER SUPPLY, CIRCUIT ANALYSES,** (Refer to Figures 4-1 and 7-1). – The regulated power supply employed in the RD-505 comprises: (1) an Input Control Circuit; (2) a DC to DC Converter; (3) one full-wave and one half-wave rectifier; (4) an Output Regulator Circuit (i.e. Differential Amplifier); (5) and a battery pack consisting of three nickel-cadmium cells.

(1) **INPUT CONTROL CIRCUIT, CIRCUIT ANALYSIS** (See Figure 4-6). – The Input Control Circuit comprises transistors Q101 and Q114 and resistor R132. Regulation of the collector to emitter current of transistor Q101 regulates, in turn, the amount of input voltage applied to the center tap (of both primary windings) of transformer T101. This regulation is accomplished via transistor Q114 which serves as a buffer amplifier for transistor Q105 in the Differential Amplifier (paragraph 4-3e3). Transistor Q114 also starts the oscillation process of the DC to DC Converter (paragraph 4-3e2) when voltage is first applied.

Battery voltage (+3.3 to +4.2 vdc) is applied simultaneously to: the emitter of Q101, and via resistor R132 to the base of Q114. Since the base circuit of transistor Q101 is completed through the collector-to-emitter circuit of transistor Q114, Q101 is cutoff until Q114 conducts. However, as soon as battery voltage is applied, Q114 is forward biased and conducts heavily and the following circuit conditions exist:

(a) As a result of Q114 collector current, the base of Q101 is driven negative and Q101 conducts heavily.

(b) Voltage is applied (via the collector-to-emitter circuit of Q101) to the primary center taps of transformer T101, and the DC to DC Converter begins to oscillate (paragraph 4-3e2).

(c) Oscillation of the DC to DC Converter induces voltages in the secondary windings of transformer T101.

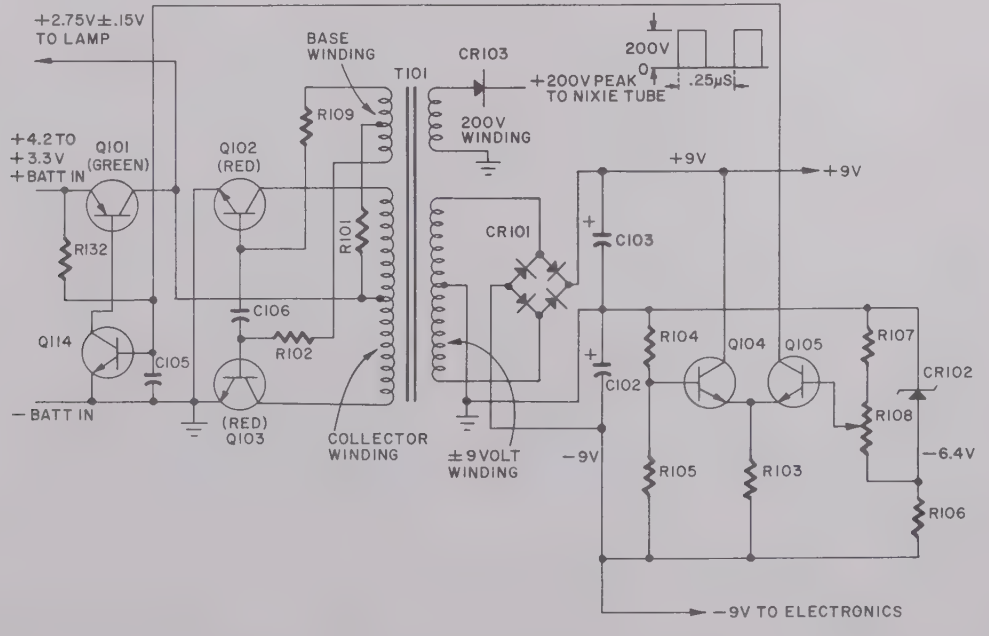
The voltage induced in one of the secondary windings of T101 is rectified by CR101 and the result is a positive and negative output voltage (i.e. +9 vdc and –9 vdc). If the negative output tends to increase or decrease, the following circuit conditions exist:

(a) There is a corresponding increase or decrease in the collector current of transistor Q105 (located in the Differential Amplifier).

(b) The change in Q105 collector current causes a corresponding change in base/emitter bias of Q101. As a result, the collector current of Q101 changes accordingly.

(c) As the collector current of Q101 changes, the input voltage to transformer T101 changes accordingly.

(2) **DC-TO-DC CONVERTER, CIRCUIT ANALYSIS** (Refer to Figures 4-6 and 7-1). – The DC-TO-DC Converter comprises: a saturable core, square-wave oscillator (Q102, Q103, and T101), a full-wave bridge rectifier (CR101), a half-wave rectifier (CR103) re-



301-6

Figure 4-6. Power Supply, Schematic Diagram

sistors R101, R102 and R109, and capacitors C102 and C103.

Operation of the oscillator circuit depends upon the switching action of transistors Q102 and Q103. As a result of Input Control Circuit action (refer to paragraph 4-3e1), battery voltage is applied to the primary windings of transformer T101 and is then extended as base bias to Q102 and Q103. Because of transistor unbalance and the unbalance of external circuitry, more current will flow through one part of the transformer T101 collector winding (see figure 4-8) and oscillation takes place. If, for example, more current flows initially through the T101 winding connected to the collector of Q102, then the voltage induced in the feedback winding will be of such polarity as to: (1) increase the forward bias on the base of Q102 thus driving it to heavy conduction; (2) apply reverse bias to the base of Q103 thus driving it to cutoff. When transformer T101 reaches saturation, induced voltages in the secondary and feedback windings fall to zero, the base driving current (i.e. base bias) for Q102 is removed, Q102 becomes nonconducting, and current flow in the collector circuit and corresponding winding of T101 ceases. As the current flow in one part of T101 primary falls to zero, voltages of opposite polarity are induced in the secondary and feedback windings. The voltage induced in the feedback winding of T101 will now drive Q103 into conduction and Q102 further into cutoff. When Q103 conducts, transformer T101 again reaches saturation and the entire process is repeated. The output developed across the secondary windings of T101 is essentially a 4-kHz square-wave signal. The output of the 200-volt winding is rectified by CR103 to provide a pulsating d-c signal (at 4-kHz) as shown in figure 4-6. The output of the ±9 volt winding is rectified by CR101 and filtered by capacitors C102 and C103.

(3) **OUTPUT REGULATOR (DIFFERENTIAL AMPLIFIER), CIRCUIT ANALYSIS.** — Refer to figures 4-6 and 7-1. The Differential Amplifier Circuit comprises transistors Q104 and Q105, Zener diode CR102, and resistors R103 through R108 inclusive.

The Differential Amplifier compares a sample of a highly-stable reference voltage to a sample of the –9 vdc output (output requiring closest tolerances) of the power supply. Any difference between the two nominally identical signals is amplified and then used to correct (increase or decrease) the voltage applied to the primary windings of transformer T101.

Refer to figure 4-6. A sample of the reference voltage (developed across Zener diode CR102) and a sample of the –9 vdc power supply output are applied to the base of transistors Q105 and Q104 respectively. If there is an increase or decrease in the –9 vdc signal, there is a corresponding change in the base bias of Q104 which results in a change in the collector-to-emitter current. Note that the emitters of both transistors (Q104 and Q105) are connected at a common point to resisor R103 (a constant-current load); in other words, this junction acts as a summing point. As Q104 current changes, the collector-to-emitter current of Q105 compensates (increases or decreases) as required to maintain constant current through resistor R103. This change in Q105 collector current is felt as a change in base bias for transistor Q114 of the Input Control Circuit (paragraph 4-3e1) which, in turn, alters the input voltage to transformer T101.

For example, if the –9 vdc output of CR101 tends to increase (i.e. become more negative), the following circuit conditions exist:

(a) The base of Q104 is driven more negative causing a decrease in forward bias. This decrease in bias results in an increase in collector-to-emitter resistance and a decrease in collector current.

(b) The junction of resistor R103 and the emitters of both transistors becomes more negative thus increasing the forward bias on the base/emitter junction of Q105.

(c) The collector-to-emitter current of Q105 increases and drives the base of Q114 (located in Input Control Circuit) more negative.

(d) Q114 collector current decreases; the base of Q101 is driven more positive; the collector-to-emitter resistance of Q101 is increased, and voltage applied to transformer T101 is decreased.

f. **BATTERY CHARGER, CIRCUIT ANALYSIS** (Refer to Figure 7-2). — The battery charger comprises a step-down transformer (T601), a full-wave rectifier (CR601 and CR602), lamp L601 and load resistor R601. Circuit analysis is similar to that of any a-c/d-c power supply employing conventional full-wave rectification. Lamp L601 and resistor R601 form a series dropping network that maintains the charging current between 165ma and 220ma over a line-voltage change of 85 volts to 135 volts. The function of L601 is to maintain a constant current over this line-voltage range. The no-load voltage at P602 is +12 vdc (as measured with a VOM) when the line is at 120 volts. The output voltage during charging is dependent upon the state of charge of the batteries and can range from 3.0 to 4.5 volts. The charger is short-circuit proof because of the current-limiting characteristics of L601.

SECTION 5

MAINTENANCE

5-1. PREVENTIVE MAINTENANCE

a. **GENERAL.** – The RD-505 has been engineered to provide long-term, trouble free operation. However, in order to prevent equipment failure due to corrosion, dust, or other destructive elements, it is suggested that a schedule of preventive maintenance be set up and adhered to.

Preventive maintenance for the RD-505 consists of: (1) battery testing and re-charging; (2) routine visual inspection and cleaning. Cleaning is necessary because dust or dirt may accumulate on certain components and not only reduce the efficiency of the instrument, but also increase component wear. Figures 5-1 through 5-8 at the end of this section will facilitate the location/identification of components.

b. **INSPECTION AND CLEANING OF OPTICAL COMPONENTS.** – The filter wheel assembly and all filters are contained in a sealed compartment; routine inspection and cleaning of these components is unnecessary. The optical light source (lamp L501), the Zero Adjust Plaque and the Color Reference Plaque should be inspected and cleaned periodically as follows:

(1) Rotate Filter Selector (2, figure 3-1) as required so that visual filter is in measuring position.

(2) Set instrument on its back and slide access plate (7, figure 5-1) downwards toward rear of instrument until access plate is completely free of recessed channel formed by Target Plate Sub-assembly (4, figure 5-1) and base of instrument.

(3) Tilt instrument forward and allow Reference Plaque Assembly (3, figure 5-1) to drop clear of Standards Selector and base of instrument. Tilt instrument backwards, lamp L501 should be readily accessible (see figure 5-4). Inspect lamp L501 for accumulation of dust and/or dirt; clean lamp L501 as required with lens brush.

(4) Examine color chips on Color Reference Plaque (5, figure 5-4) for fingerprints and/or accumulation of dust or dirt. Using cotton swab ("Q" tip) dampened with solution of mild detergent and water, clean color chips as required.

(5) Tilt instrument slightly forward and swing Zero Adjust Plaque forward from its storage position until white color chip is readily accessible. Examine white color chip for fingerprints and/or accumulation of dust or dirt. Using cotton swab dampened with solution of mild detergent and water, clean white color chip as required.

(6) Reassemble all components in reverse order of disassembly.

c. **INSPECTION AND CLEANING OF ELECTRICAL, ELECTRONIC, AND MECHANICAL COMPONENTS.** – Concurrent with optical system inspection and cleaning (paragraph 5-1b), the inspection and cleaning (if required) of RD-505 electrical, electronic, and mechanical components should be performed. Proceed as follows:

(1) Loosen and remove screws (1, figure 5-1) securing Base Plate Assembly to Instrument Housing.

(2) Pull Transport Lock (6, figure 5-1) out and carefully lift housing from Base Plate Assembly.

(3) Check all components for dirt, corrosion, charring, discoloring, or grease. Dust should be removed with any suitable cleaning solvent. Refer to figures 5-2, 5-3, and 5-6 through 5-8 for component location.

CAUTION

Use of carbon tetrachloride should be avoided because of its highly toxic effects. If using trichlorethylene, avoid contact with painted surfaces due to its paint removing effects.

NOTE

When using toxic solvents, make certain that adequate ventilation exists. Avoid prolonged or repeated breathing of the vapor. Avoid prolonged or repeated contact with skin. Flammable solvents should not be used on energized equipment or near any equipment from which a spark may be received. Smoking, "hot work," etc. should be prohibited in the immediate area.

Visual inspection of the unit can sometimes prevent downtime due to component failure. A deteriorating component will sometimes look bad before it actually affects instrument performance. Some indications of possible trouble are: discoloration of components, leaking capacitors or transformers, dirty or pitted switch contacts, and damaged wiring. Any component (except those on the Log Converter and High-Impedance Boards*) found in this condition should be replaced. In addition, all hardware should be checked for tightness.

NOTE

Log Converter and High-Impedance Boards should be replaced as complete and matched units. Individual components on either of these boards are critical and their replacement requires complete realignment and recalibration of the p/c board itself and of the instrument.*

*The Log Converter and High-Impedance P/C Board comprises: (1) two Log Converter stages; (2) the Subtraction Amplifier Stage; (3) impedance matching circuitry.

d. **CHARGING BATTERIES.** — The nickel-cadmium cells employed in the RD-505 should be maintained in a charged condition at all times. If the battery test (paragraph 3-5) reveals a discharged condition, proceed as follows:

NOTE

If the RD-505 is inactive for an extended period of time, the battery cells should be: (1) placed on continual charge; or (2) tested on a monthly basis and charged as required.

(1) Ensure that 115/230 switch of battery charger is set at appropriate position for available line voltage.

CAUTION

Do not connect battery charger to RD-505 if battery cells have been removed from instrument circuitry.

(2) Insert two-conductor phone plug of battery charger into BATT CHG jack of RD-505.

(3) Connect a-c input plug of battery charger to convenience outlet (i.e. a-c input power source). Lamp on side of battery charger should light to indicate that battery cells are being charged.

NOTE

The RD-505 can be used while the battery cells are being charged.

5-2. TROUBLESHOOTING

a. **GENERAL.** — A TROUBLE-REMEDY chart is given in table 5-1 as a guide for isolating the more-obvious malfunctions that may occur. To an experienced technician, the trouble indications and probable causes given in table 5-1 may seem overly simplified; nevertheless the information given in table 5-1 should be observed before more complex troubleshooting techniques/procedures are tried. If the reason for equipment malfunction is not obvious and the faulty component cannot be isolated via use of information given in table 5-1, proceed with point-to-point voltage measurements and/or scope measurements outlined in paragraph 5-2c. A basic knowledge of how each stage of the RD-505 functions will facilitate trouble-shooting procedures; refer to Section 4 of this manual for detailed circuit analyses or for overall functional analysis.

CAUTION

Voltage measurements and component replacement procedures should be attempted only by experienced technicians as extensive damage can result from improper testing/workmanship.

CAUTION

Read paragraphs 5-3 and 5-4 before attempting to replace any component. Particular attention should be paid to paragraph 5-4a.

b. **TEST EQUIPMENT REQUIRED.** — Table 5-2 lists all test equipment required to troubleshoot, align, or calibrate the RD-505.

c. **VOLTAGE MEASUREMENTS.** — Table 5-3 provides discrete voltage measurements for each stage of the RD-505; appropriate test points are illustrated in figures 5-2, 5-3, and 7-1. Coupled with the circuit-analysis information provided in Section 4 of this manual, these voltage measurements will facilitate the task of troubleshooting the RD-505. Any significant deviation from values given in table 5-3 should indicate (and help to isolate) the probable source of trouble.

TABLE 5-1. PRELIMINARY TROUBLESHOOTING GUIDE, RD-505

TROUBLE INDICATION	VERIFICATION OF TROUBLE	PROBABLE CAUSE
1. RD-505 Inoperative	Battery test (paragraph 3-5) indicates that battery cells are weak.	Batteries discharged.
		Filter Selector knob positioned too high on shaft.
	Lamp L601 of Battery charger does not glow when charger is connected to RD-505 and is energized.	Fuse wire (located between battery cells) burned up.
2. Meter M501 indicates but Nixie tube does not glow.		Defective Nixie tube.
	No voltage at anode (test point 1X, figures 7-1 and 5-2) of Nixie tube.	Open high-voltage rectifier CR103.
	One filament ("0", "1", or "2") does not glow when appropriate range is selected.	Open drive transistor as per: Filament — Transistor 0 — Q109 1 — Q110 2 — Q111
3. One filament of Nixie tube glows continuously regardless of density range.		Shorted drive transistor as per: Filament — Transistor 0 — Q109 1 — Q110 2 — Q111
4. Nixie tube indicates but Meter M501 is inoperative or meter is pegged up scale.		Integrated circuit Q108 defective.
		Broken connection to meter.
5. Meter M501 operates but does not respond normally. Nixie Tube functions properly.		Transistor Q112 or Q113 defective.
		Integrated Circuit Q108 defective.
6. Meter M501 tends to "hang up" at switch points and Nixie tends to display two digits at one time.		Lack of ground on Optical housing.
		Capacitor C102 or C103 of power supply defective.
7. Meter M501 is pegged up or down scale.		Lamp L501 burned out.
		Filter Selector knob positioned too high on shaft.
		Filter Selector knob set between filter positions.
	Meter M501 pegs in only one filter position.	Defective Zero Adjust or Calibrate potentiometer.
8. Meter M501 is pegged up scale when high-density samples are measured.		Potentiometer R327 defective or improperly adjusted.

TABLE 5-1. PRELIMINARY TROUBLESHOOTING GUIDE, RD-505 (CONT.)

TROUBLE INDICATION	VERIFICATION OF TROUBLE	PROBABLE CAUSE
9. Zero Adjust and Calibration Settings are upset when Filter Selector is rotated.	_____	Filter Selector knob positioned too low on shaft.
10. Meter M501 cannot be set at center-reading "Null" point.	_____	Potentiometer R326 defective or improperly adjusted.
11. Instrument cannot be calibrated on any color.	_____	Zero Adjust potentiometers improperly adjusted.
	_____	Missing color references.
		Gears and/or mechanical linkage for Standard Selector (8, figure 5-1) defective or faulty.
12. Instrument is energized but no indication is obtained on both Meter M501 and digital display.	_____	Level Detectors Q106 and/or Q107 defective.
13. Battery Charger inoperative or operating improperly.	_____	Fuse F101 of Battery Charger blown.
		Lamp L101 of Battery Charger burned out.
		115/230 switch in wrong position.
14. No output from power supply (i.e. DC to DC Converter will not start).	_____	Open transistor Q101 or Q114.

TABLE 5-2. REQUIRED TEST EQUIPMENT

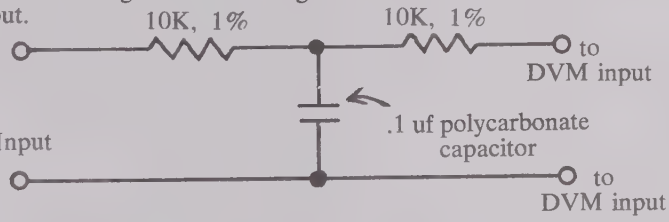
TEST EQUIPMENT	PURPOSE	REQUIRED SPECIFICATIONS	RECOMMENDED INSTRUMENT
1. Digital Voltmeter (see Note 1)	Alignment/Calibration procedure (par. 5-5).	(see note 1)	Fairchild Model 7050 or equivalent
2. Oscilloscope			Tektronix Model 516A or equivalent
3. Volt-Ohmmeter	Point-to-point voltage measurements (par. 5-2c).	Input Impedance = 20,000 ohm/volt	Simpson Model 260 or equivalent

TABLE 5-2. REQUIRED TEST EQUIPMENT (CONT.)

Test Equipment	Purpose	Required Specifications	Recommended Instrument
4. Electrometer	Measuring input/offset voltage of Log Converters (table 5-3; test points 3A, 3B, 3C, 3D, 3F & 3G).		Keithley Model 610B or equivalent
5. DVM outlet plug	Grd. Connection for other test equipment.		

Notes:

1. The Model 7050 DVM generates noise that could adversely affect the operation of the Log Converter stages. The isolating filter shown below should be used on the DVM input.



2. To facilitate measurements, it is recommended that special miniature probes (such as "Kleps 30" – which are commercially available) be obtained and used.

TABLE 5-3. D-C VOLTAGE MEASUREMENTS, RD-505

TEST POINT	VOLTAGE MEASUREMENT Max.	VOLTAGE MEASUREMENT Min.	RELATED ILLUSTRATIONS	
		NOTE *The test setup for Voltage Measurements is given at the end of this table.*		
1S	+4.2	+3.3	Figure 7-1, 5-2	POWER SUPPLY
1T	+2.9	+2.6	Figure 7-1, 5-2	
1W	+ .75	+ .50	Figure 7-1, 5-2	
1X	+220	+180	Figure 7-1, 5-2	
1Y	+10	−10	Figure 7-1, 5-2	
1Z	+10	−10	Figure 7-1, 5-2	
1AA	+9.5	+8.5	Figure 7-1, 5-2	
1BB	−9.5	−8.5	Figure 7-1, 5-2	
1CC	−4.3	−3.8	Figure 7-1, 5-2	
1DD	−4.9	−4.4	Figure 7-1, 5-2	
1EE	−4.3	−3.8	Figure 7-1, 5-2	

TABLE 5-3. VOLTAGE MEASUREMENTS, RD-505 (CONT.)

TEST POINT	VOLTAGE MEASUREMENT Max.	Min.	RELATED ILLUSTRATIONS	
3A*	+1mv	−1mv	Figure 7-1	LOG CONVERTER & SUBTRACTION AMPL.
3B*	+1mv	−1mv	Figure 7-1	
3C*	+4.5	+0.6	Figure 7-1, 5-3	
3D*	+4.5	+0.6	Figure 7-1, 5-3	
3E	+6.5	+6.0	Figure 7-1, 5-3	
3F*	+4.5	+0.6	Figure 7-1, 5-3	
3G*	+4.5	+0.6	Figure 7-1, 5-3	
3H	+0.55	+0.35	Figure 7-1, 5-3	
3J	+0.55	+0.35	Figure 7-1, 5-3	
3K	+0.9	0.0	Figure 7-1, 5-3	
3L	+0.9	0.0	Figure 7-1, 5-3	
3M	−0.9	0.0	Figure 7-1, 5-3	
3N	+0.9	0.0	Figure 7-1, 5-3	
3P	+3.0	0.0	Figure 7-1, 5-3	
3R	+0.6	0.0	Figure 7-1, 5-3	
	* Measure with Keithley 610B Electrometer or equivalent.			
1A	+3.0	0.0	Figure 7-1, 5-2	HYBRID DISPLAY STAGE
1B	+ .03	− .03	Figure 7-1, 5-2	
1C	+ .03	− .03	Figure 7-1, 5-2	
1D	+8.5	−8.5	Figure 7-1, 5-2	
1E	+8.5	−8.5	Figure 7-1, 5-2	
1F	+1.8	−0.9	Figure 7-1, 5-2	
1G	+0.9	−3.0	Figure 7-1, 5-2	
1H	+0.9	−0.9	Figure 7-1, 5-2	
1J	+0.9	−0.9	Figure 7-1, 5-2	
1K	−0.1	−6.7	Figure 7-1, 5-2	
1L	−0.1	−6.7	Figure 7-1, 5-2	
1M	−6.08	−6.72	Figure 7-1, 5-2	
1N	60V (Square Wave Signal) (See Figure 7-1)		Figure 7-1, 5-2	
1P			Figure 7-1, 5-2	
1R			Figure 7-1, 5-2	

TEST SETUP FOR VOLT. MEAS.

1. Energize instrument. For convenience, a dime or a penny (or small washer, etc.) can be used in conjunction with a weighted object to keep PRESS TO READ switch (1, figure 3-1) depressed while voltage measurements are made.

2. DVM outlet plug should be plugged into DVM OUT jack (located on side of RD-505), and its ground terminal should be used as a ground point (for test equipment). Chassis ground should not be used or voltage measurements will be erroneous.

5-3. REPAIR AND REPLACEMENT OF OPTICAL COMPONENTS

a. **GENERAL.** — Repair procedures for RD-505 optical components are not applicable. Please note that certain of the optical components (i.e. photodiodes, filters, etc.) are contained in a sealed housing (8, figure 5-7); these are matched components and their replacement requires critical selection and complete recalibration of the instrument. The occasions for replacement of these components will be rare; however, if such occasion should arise, it is suggested that the instrument be returned to the manufacturer for repair and realignment. To replace the optical light source, the Zero Target Plaque, or the Color Reference Plaque, proceed as outlined in the following paragraphs.

NOTE

Replacement parts should have the same (or better) parameters as the original part. Refer to Section 6 of this manual when ordering replacement parts.

b. **REPLACEMENT OF OPTICAL LIGHT SOURCE** (Refer to Figure 5-4). — Spare lamps for the light source (lamp L501) contained in the optical system of the RD-505 should be obtained from your authorized Macbeth dealer or ordered directly from the Macbeth Corporation, Newburgh, New York 12550. A burned-out lamp is easily replaced as follows:

(1) Ensure that optical housing is locked in rearward (i.e. storage) position. Tilt instrument backwards and slide Access Plate (7, figure 5-1) toward rear of instrument until it is clear of Target Plate Subassembly (4, figure 5-1). Set Access Plate aside.

(2) Carefully remove Reference Plaque Subassembly (5, figure 5-4) from Standards Selector (4, figure 5-4). Note that the Reference Plaque Subassembly will drop free of Standards Selector if instrument is tilted forward.

(3) Loosen and remove four retaining screws (9, figure 5-1) securing Target Plate Subassembly to Base Plate. Set Target Plate Subassembly aside.

CAUTION

When performing step 4 below, note the color coding of the lamp leads before disconnecting. Polarity must be correct when lamp leads are reconnected.

(4) Loosen (do not remove) screws securing lamp leads to terminal points on base of photodiode housing; disconnect lamp leads.

(5) Engage edge of dime or penny (or similar object) in slots of Light-Source Retainer (3, figure 5-4); loosen and remove retainer by turning it counterclockwise.

(6) Carefully lift light source just clear of lamp housing (1, figure 5-4). Gently pull fiber-optic cable free from tubular receptacle of Light Source Subassembly.

(7) Insert fiber-optic cable into tubular receptacle of new Light Source Subassembly, and reassemble instrument in reverse order of disassembly. Take care that polarity of lamp leads is correct; ensure that all hardware is secured properly.

(8) Realign/recalibrate instrument as described in paragraph 5-5.

c. **REPLACEMENT OF ZERO PLAQUE SUBASSEMBLY** (4, Figure 5-5). — Under normal usage, there should be no reason for replacing the Zero Plaque Subassembly. However, in the event that the white color chip on the Zero Plaque Subassembly becomes damaged (scratched, discolored, etc.), replace the plaque as follows:

(1) Ensure that optical housing is locked in rearward position (i.e. storage position).

CAUTION

When performing step 2 below, note that the Access Plate (7, figure 5-1) and the Reference Plaque Subassembly (3, figure 5-1) are held in position by the Target Plate Subassembly. These components can be damaged if dropped when the Target Plate Subassembly is separated from Base Plate.

(2) Tilt instrument backwards; loosen and remove four retaining screws (9, figure 5-1) securing Target Plate Subassembly to Base Plate. Target Plate Subassembly, Access Plate, and Reference Plaque Subassembly are now loose; set Access Plate and Reference Plaque Subassembly aside.

(3) Using pointed tool (such as jeweler's screwdriver, awl, etc.) slip retaining ring (3, figure 5-5) off Zero Pivot Stud. Lift Zero Plaque Subassembly off Zero Pivot Stud (1, figure 5-5).

(4) Place new Zero Plaque Subassembly on Zero Pivot Stud, and reassemble instrument in the reverse order of disassembly.

d. **REPLACEMENT OF REFERENCE PLAQUE SUBASSEMBLY** (5, Figure 5-4). – As with the Zero Plaque Subassembly, the occasions for replacing the Reference Plaque Subassembly will be rare. However, situations may arise when the user will want to replace the Reference Plaque Subassembly provided with the instrument with a plaque containing color chips of his own choice. The complete procedure for changing/replacing the Reference Plaque Subassembly and for installing special color chips is given in paragraph 3-4.

5-4. REPAIR AND REPLACEMENT OF ELECTRICAL / ELECTRONIC COMPONENTS

CAUTION

Extensive damage to the instrument can result from improper workmanship. Only experienced technicians should attempt repair/replacement procedures beyond the scope of: (1) battery replacement (paragraph 5-4b); (2) meter replacement (paragraph 5-4c); (3) switch replacement (paragraphs 5-4d and 5-4e); (4) replacement of output or input jack (paragraph 5-4f). Note also that RD-505 wiring is critical and cannot be changed in any manner (refer to paragraph 5-4a).

a. **WIRE REPAIR/REPLACEMENT** (Refer to figure 7-3). – The wiring scheme of the RD-505 has been designed to minimize problems due to ground loops and crosstalk. Further, wire-lengths have been chosen to provide specific resistance/s. If the wiring of the RD-505 is changed in any manner (i.e. wire length or scheme), instrument performance will, most likely, be affected.

b. **BATTERY REPLACEMENT.** – To replace the batteries, proceed as follows:

CAUTION

Because of their high current-delivering capabilities, nickel-cadmium cells should be handled with care. During handling, make sure that: (1) cells do not become short circuited; (2) battery leads do not become crossed with other wiring. Also, ensure that polarity of cells is correct when installed in unit.

(1) Tilt instrument backwards; loosen and remove six screws (1, figure 5-1) securing Base Plate to Instrument Housing. Tilt instrument forward.

(2) Ensure that Transport Lock (6, figure 5-1) is pulled out so that Optical Housing is not locked to Instrument Housing. Lift Instrument Housing from base plate.

(3) Loosen (do not remove) screws (10, figure 5-1) securing battery clamp to base plate so that batteries slide out easily.

NOTE

When performing step 4 below, carefully note which wires are connected to each battery cell. This could eliminate the necessity of referring to the schematic (figure 7-1) and/or the wiring diagram (figure 7-3) when connecting wires to new cells.

(4) Using pencil-type soldering iron (30 watts or less), unsolder wires connected to each end of battery cells. Position new cells so that polarity corresponds with wiring scheme. Connect and solder wires to new cells (do not apply excessive heat as cells can be damaged). Set battery cells in position and secure battery clamp.

(5) Reassemble instrument in reverse order of disassembly.

c. **METER REPLACEMENT.**—Proceed as follows:

(1) Tilt instrument backwards; loosen and remove six screws (1, figure 5-1) securing Base Plate to Instrument Housing. Tilt instrument forward.

(2) Ensure that Transport Lock (6, figure 5-1) is pulled out so that Optical Housing is not locked to Instrument Housing. Lift Instrument Housing from base plate and set Instrument Housing aside.

(3) Loosen and remove screw (5, figure 5-6) securing meter bracket to support arm.

CAUTION

When performing steps 4 and 5 below, do not put excessive strain on connecting wires.

(4) Carefully slide meter bracket (with meter) off of mounting pins on support arm (8, figure 5-6).

(5) Note which wires are connected to each terminal of meter; unsolder and disconnect wires. If any wire has to be replaced, pay particular attention to the information given in paragraph 5-4a.

(6) Loosen and remove four nuts and starwashers from meter mounting studs (13, figure 5-6). Lift meter from meter bracket.

(7) Mount new meter to meter bracket, connect and solder appropriate wires, and reassemble instrument in the reverse order of disassembly.

d. **REPLACEMENT OF PRESS-TO-READ SWITCH** (SW501). — Access to PRESS-TO-READ Switch SW501 (13, figure 5-7) is obtained by first separating the Base Plate Assembly and Instrument Housing and then removing the Knob Assembly. Proceed as follows.

(1) Loosen and remove six screws (1, figure 5-1) securing Base Plate to Instrument Housing.

(2) Ensure that Transport Lock (6, figure 5-1) is pulled out so that Optical Housing is not locked to Instrument Housing. Lift Instrument Housing from Base Plate.

(3) Using allen wrench, loosen (do not remove) set screw (8, figure 5-7) securing Knob Assembly (7, figure 5-7) to selector shaft. Remove Knob Assembly and set it aside.

(4) Remove switch actuator (12, figure 5-7) from selector shaft and set actuator aside.

(5) Loosen and remove three screws securing Optical Housing cover (6, figure 5-7). Remove cover and set it aside.

(6) Loosen and remove screw securing PRESS-TO-READ switch to Contact Support Block (2, figure 5-6).

(7) Unsolder and disconnect wires connected to terminal of PRESS-TO-READ switch.

(8) Connect and solder wires (disconnected in step 7 above) to appropriate terminal of new switch. Mount new switch on Contact Support Block; and reassemble instrument in reverse order of disassembly.

e. **REPLACEMENT OF BATT TEST SWITCH** (SW502). — To replace BATT TEST SWITCH SW502 (6, figure 5-6), proceed as follows.

(1) Tilt instrument backwards; loosen and remove six screws (1, figure 5-1) securing Base Plate to Instrument Housing. Tilt instrument forward.

(2) Ensure that Transport Lock (6, figure 5-1) is pulled out so that Optical Housing is not locked to Instrument Housing. Lift Instrument Housing from Base Plate and set Instrument Housing aside.

(3) Loosen and remove two screws securing BATT TEST Switch to Connector Bracket Subassembly (7, figure 5-6).

(4) Unsolder and disconnect wires connected to terminals of switch. If any wire has to be replaced, pay particular attention to the information given in paragraph 5-4a.

(5) Connect and solder wires (disconnected in step 4 above) to new switch; reassemble instrument in reverse order of disassembly.

f. **REPLACEMENT OF BATT CHG OR DVM OUT JACK.** — Both jacks (BATT CHG and DVM OUT) are mounted on the Connector Bracket Subassembly (7, figure 5-6), and replacement procedures are obvious upon inspection. If any of the connecting wires have to be replaced, pay particular attention to the information given in paragraph 5-4a.

g. **REPLACEMENT OF PRINTED CIRCUIT (P/C) BOARDS OR P/C BOARD COMPONENTS.**

(1) GENERAL. — When replacing any of the components, assemblies, or subassemblies of the RD-505, it is important to use replacement parts that have the same (or better) performance parameters as the original part. Therefore, it is imperative to refer to the parts list (Section 6) of this manual when ordering replacement parts.

Soldering techniques used when replacing components are, for the most part, conventional; however particular attention should be paid to the following:

(a) A pencil-type soldering iron of 30 watts or less should be used.

(b) A solder-absorbing material such as "Soder Wick" (a product of Solder Removal Co.) should be used to clean the eyelets of the p/c board.

(c) Considerable care must be exercised to avoid overheating the solder point and causing an "open" in the circuitry on the opposite side of the p/c board.

(d) Considerable care must be exercised to keep solder from flowing onto an adjacent strip and causing a short circuit.

(2) LOG CONVERTER/SUBTRACTION AMPLIFIER P/C BOARD AND HIGH-IMPEDANCE P/C BOARD (11, Figure 5-7). — The Log Converter/Subtraction Amplifier p/c board and the High-Impedance p/c board are soldered together as one unit (designated "Log Converter Assembly"). Components contained on these two boards are critically selected and their replacement requires complete realignment and recalibration of the p/c boards and of the instrument. For replacement of individual components on the Log Converter Assembly, it is suggested that the instrument be returned to the manufacturer for repair and realignment. Further, the Log Converter/Subtraction Amplifier board and the High-Impedance board must be replaced as a matched pair; to replace these boards (i.e. the Log Converter Assembly), proceed as follows.

(a) Tilt instrument backwards; loosen and remove

six screws (1, figure 5-1) securing Base Plate to Instrument Housing. Tilt instrument forward.

(b) Ensure that Transport Lock (6, figure 5-1) is pulled out so that Optical Housing is not locked to Instrument Housing. Lift Instrument Housing from Base Plate.

(c) Using allen wrench, loosen (do not remove) set screw (8, figure 5-7) securing Knob Assembly (7, figure 5-7) to selector shaft. Remove Knob Assembly and set it aside.

(d) Remove switch actuator (12, figure 5-7) from selector shaft and set actuator aside.

(e) Loosen and remove three screws securing Optical Housing cover (6, figure 5-7). Remove cover and set it aside.

(f) Disconnect plug and wiring harness from Log Converter Assembly.

(g) Loosen and remove two screws (see figure 5-3) securing Log Converter Assembly to Optical Housing. Carefully tilt assembly backwards; take care not to strain or break connecting wires.

(h) Loosen and remove four screws (3, figure 5-7) securing Photodiode Housing Cover Assembly (4, figure 5-7) in place. Remove Cover Assembly and set it aside.

NOTE

When performing step i below, carefully note where each wire is terminated. This could eliminate the necessity of referring to the schematic diagram (figure 7-1) and/or the wiring diagram (figure 7-3) when re-connecting wires.

CAUTION

Soldering irons should not be applied to the anodes of photodiodes. When performing steps i and j below, connections to anode caps must be made with caps removed from photodiodes.

(i) Remove anode caps from photodiodes; unsolder and disconnect wires connected to anode caps. Unsolder and disconnect all other interconnecting wires at appropriate terminals of p/c board.

(j) Pass two leads from new High-Impedance board through holes in Photodiode Housing; connect and solder leads to photodiode anode caps.

(k) Connect wires (disconnected in step i above) to appropriate terminals of new Log Converter/Subtraction Amplifier p/c board.

(l) Using clean alcohol, clean anode and surrounding area of photodiodes.

(m) Reassemble instrument in reverse order of disassembly. Take care that nothing touches anode caps or glass envelope of photodiodes once they are installed.

NOTE

When replacing Photodiode Cover assembly, the bottom edges of the cover should first be coated with a thin film of Silastic® 732 RTV Adhesive/Sealant.

(n) Align and calibrate RD-505 as described in paragraph 5-5.

(3) AUTO RANGING (HYBRID DISPLAY) AND POWER SUPPLY BOARD (10, Figure 5-7). – On the Auto Ranging and Power Supply p/c board, all components except potentiometers are replaceable as individual items. Each potentiometer is a critical component and its replacement requires complete realignment and recalibration of the p/c board and of the instrument. It is suggested that the instrument be returned to the manufacturer for repair and realignment whenever a potentiometer has to be replaced. The entire p/c board may be replaced as a single unit in the following manner:

(a) Loosen and remove six screws (1, figure 5-1) securing Base Plate Assembly to Instrument Housing Assembly. Pull Transport Lock (6, figure 5-1) out and carefully lift housing from Base Plate Assembly.

(b) Disconnect plug of wiring harness (9, figure 5-6) from Auto Ranging and Power Supply p/c board.

(c) Loosen and remove screw (located in approximate center of p/c board) securing p/c board in place. Remove p/c board.

(d) Substitute new p/c board for defective board and reassemble instrument in reverse order of disassembly.

(e) Realign and recalibrate instrument as described in paragraph 5-4.

h. **REPLACEMENT OF ZERO ADJUST OR CALIBRATE POTENTIOMETERS.** – Zero Adjust potentiometers (R401 through R404) and Calibrate potentiometers (R405 through R408) are contained in the Filter Selector Knob Assembly (see figure 5-8). Replacement procedures are readily ascertained from the information presented in figure 5-8.

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5-5. ALIGNMENT/CALIBRATION

The RD-505 should be aligned and calibrated each time a new light source is installed in the unit. Additionally, it is advisable to check instrument calibration whenever any of the electrical/electronic components are replaced. The only test equipment required to effect instrument alignment/calibration is a Macbeth 10-step calibration check plaque and a ± digital voltmeter (such as the Fairchild Model 7050 or equivalent) or a zero-center, 1-volt meter with a minimum input impedance of 20kohms/volt. The step-by-step procedure for aligning and calibrating the RD-505 is:

NOTE

Numbers enclosed in circles are items appearing in figure 3-1.

a. Insert DVM outlet plug into DVM OUT jack, then insert input lead of test meter (i.e. digital voltmeter or zero-center, 1-volt meter — see table 5-2) into outlet plug.

CAUTION

Do not depress PRESS-TO-READ switch ① while rotating Filter Selector ② , otherwise the meter circuit will be overloaded.

b. Rotate Filter Selector ② as required so that visual filter is in measuring position (i.e. white/black spot is aligned with Fiducial Mark ⑤).

c. With Optical Housing in rearward position (i.e. storage position), depress Idler Wheel ④ and adjust it as required to set Calibrate potentiometer for visual filter at approximate mid point of its complete rotational range.

d. Position Target Aperture ⑥ over zero density step of 10-step reflection check plaque. Ensure that instrument is set flat on check plaque (i.e. optical light source must be normal to sample being measured).

e. Release Transport Lock ③ by pulling it out. Move Optical Housing forward so that lamp housing is placed in contact with Zero Adjust Plaque (i.e. in measuring position).

f. With PRESS-TO-READ switch ① depressed, sequentially perform the following.

NOTE

During this step, the RD-505 may be pegged. This situation is not abnormal and no damage will result to the instrument or to the meter.

(1) Press Idler Wheel inwards toward Instrument Housing and rotate Idler Wheel fully clockwise and fully counterclockwise and determine the range limits (as noted on test meter) of Zero Adjust potentiometer (R403*). Calculate upper and lower range limit for equal ± indications centered at zero density value given on check plaque.

(2) Rotate Zero Adjust control fully clockwise or fully counterclockwise; adjust potentiometer R326 as required to establish upper or lower range limit (depending on setting of Zero Adjust Control) as determined in step 1 above.

(3) Adjust Zero Adjust Control as required to obtain meter indication corresponding to zero density value given on check plaque.

g. Release PRESS-TO-READ switch.

h. Using screwdriver, rotate potentiometer R327 fully clockwise. Move Optical Housing to rearward position.

i. Position Target Aperture over CAL. step of 10-step reflection check plaque.

j. Move Optical Housing forward so that lamp housing is placed in contact with Target Aperture (i.e. in measuring position).

k. Depress PRESS-TO-READ switch and observe density indication (i.e. display on Nixie tube ⑨ plus meter ⑩ indication).

l. Move Optical Housing to rearward position; press Idler Wheel inward toward Instrument Housing and rotate Idler Wheel in direction required to match density indication on meter ⑩ with value given on 10-step check plaque.

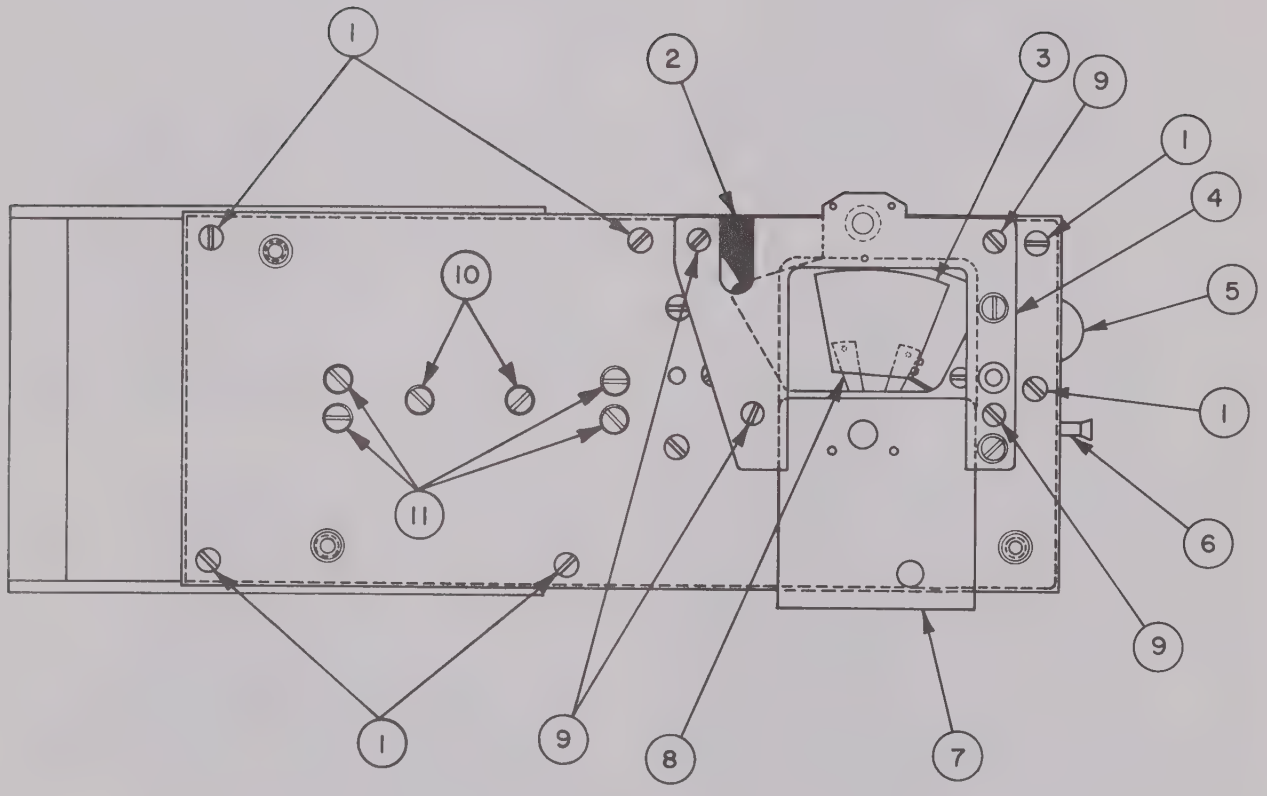
m. Repeat steps j, k, and l above until indication on meter corresponds with "Calibration" value given on 10-step check plaque. If proper indication cannot be obtained, the optical light source is probably defective; inspect light source and replace as required. Move Optical Housing to rearward position.

n. Position Target Aperture ⑥ over step 10 of reflection check plaque.

o. Move Optical Housing forward. Depress PRESS-TO-READ switch and note density indication on RD-505; indication may be lower than value recorded on reflection check plaque.

p. While depressing PRESS-TO-READ switch ① , adjust potentiometer R327 as required to obtain density indication corresponding to value recorded on check plaque.

q. Check instrument response on "CAL" step and "Step 10" of reflection check plaque and peak controls as required.



LEGEND:

1. BASE RETAINING SCREW (6)
2. ZERO ADJUST PLAQUE
3. REFERENCE PLAQUE ASSEMBLY
4. TARGET PLATE SUBASSEMBLY
5. IDLER WHEEL
6. TRANSPORT LOCK
7. ACCESS PLATE
8. STANDARDS SELECTOR
9. TARGET PLATE RETAINING SCREW (4)
10. BATTERY CLAMP RETAINING SCREW (2)
11. METER BRACKET RETAINING SCREW (4)

305-43

Figure 5-1. Base Plate Assembly

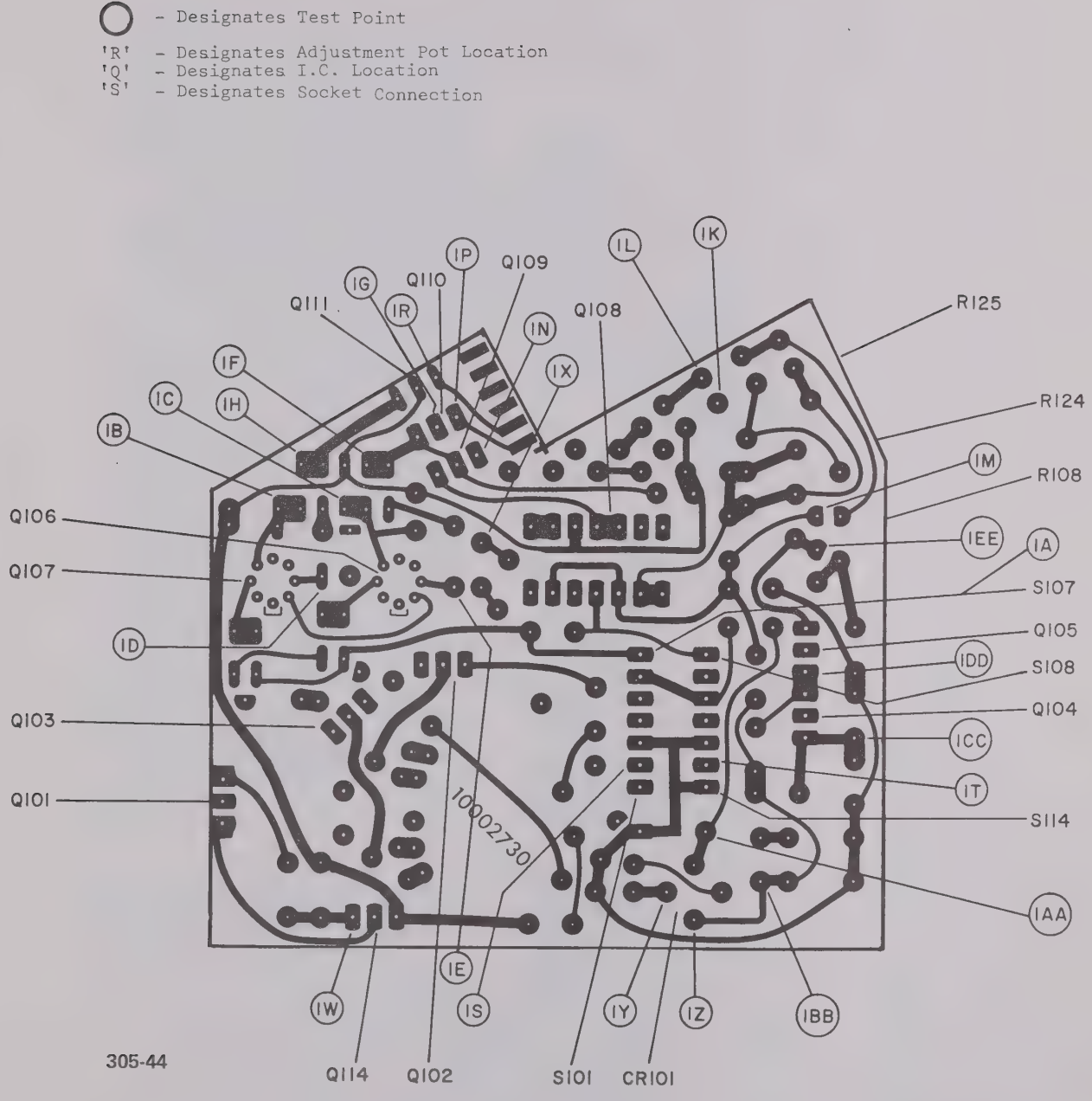


Figure 5-2. Auto Ranging and Power Supply P/C Board

◯ - Designates Test Point

'R' - Designates Adjustment Pot Location
'Q' - Designates I.C. Location
'S' - Designates Socket Connection
'H' - Designates Connection to Hi-Z Board
'T' - Designates Soldered Connection to Optical Housing

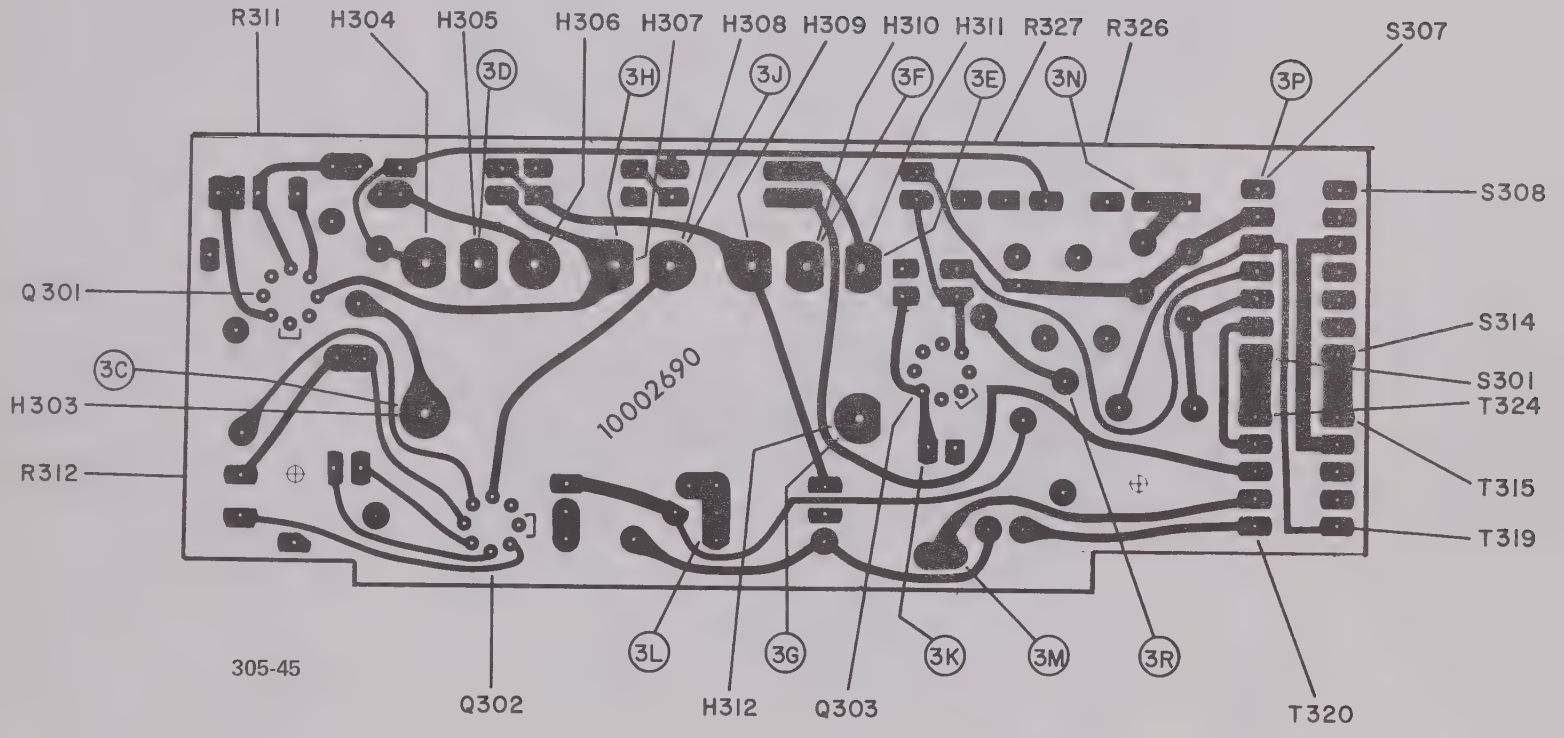


Figure 5-3. Log Converter/Subtraction Amplifier P/C Board

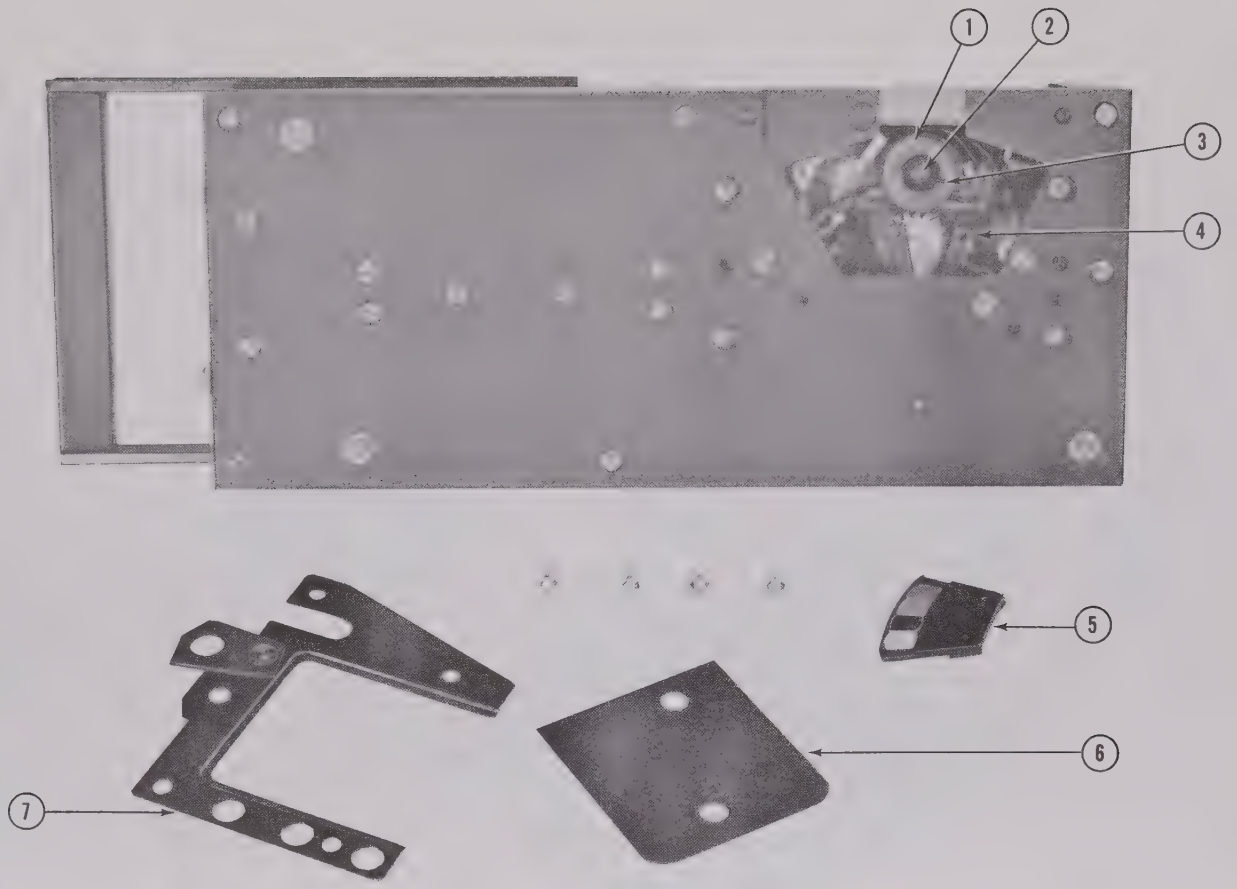


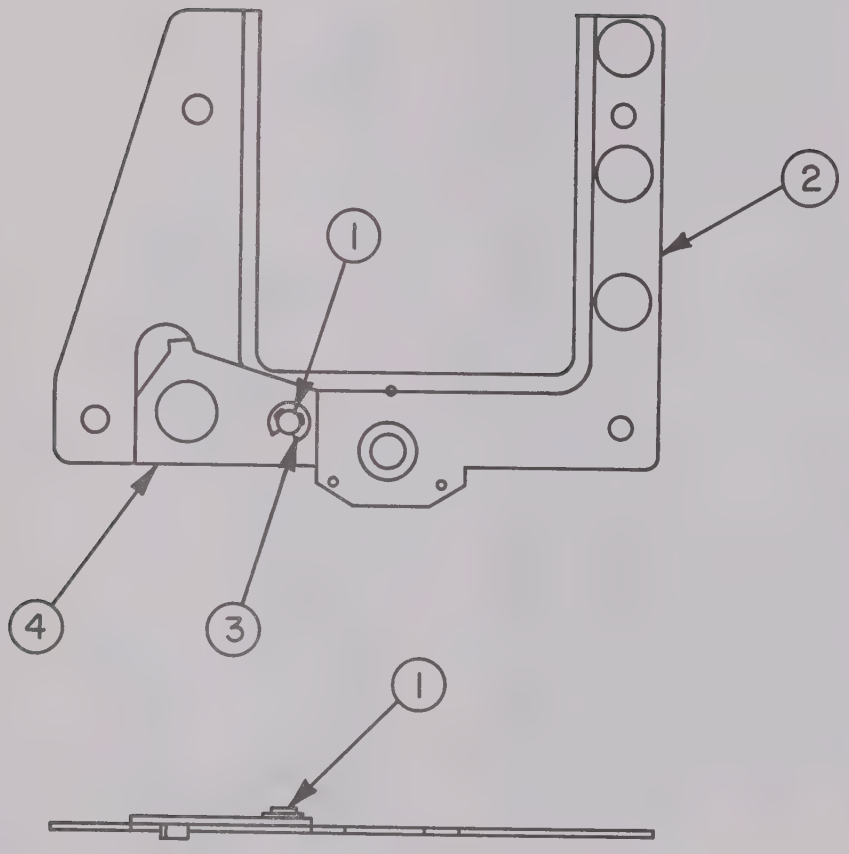
FIGURE 5-4

LEGEND

1. LAMP HOUSING
2. OPTICAL LIGHT SOURCE L501
3. LIGHT SOURCE RETAINER
4. STANDARDS SELECTOR
5. REFERENCE PLAQUE SUBASSEMBLY
6. ACCESS PLATE
7. TARGET PLATE SUBASSEMBLY

405-29

Figure 5-4. RD-505, Bottom View



LEGEND:

1. ZERO PIVOT STUD
2. TARGET PLATE SUBASSEMBLY
3. RETAINING RING
4. ZERO PLAQUE SUBASSEMBLY

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Figure 5-5. Target Plate Subassembly

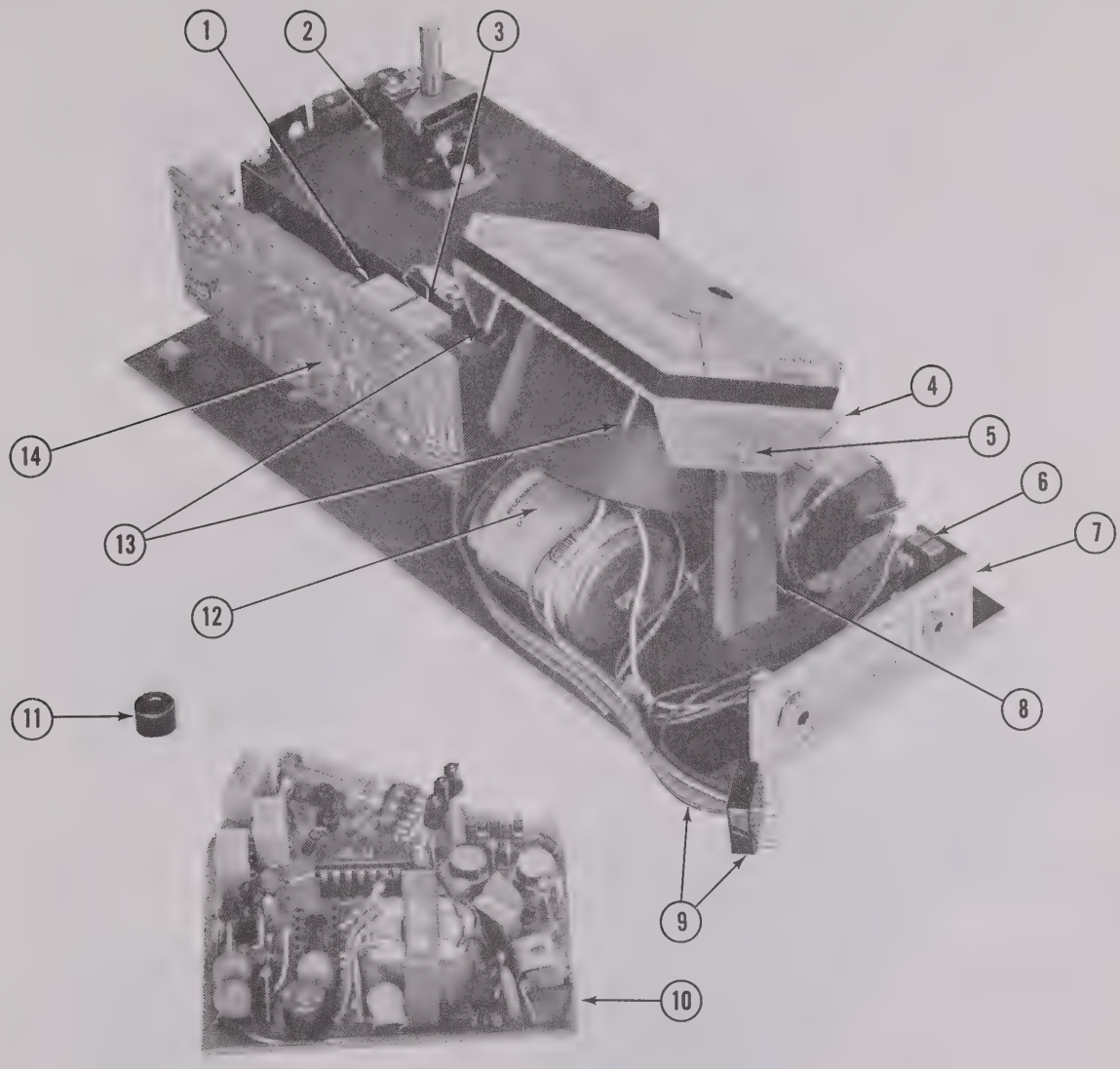


FIGURE 5-6

LEGEND

1. POTENTIOMETER R327
2. CONTACT SUPPORT BLOCK
3. POTENTIOMETER R326
4. METER BRACKET
5. SCREW
6. BATT TEST SWITCH SW502
7. CONNECTOR BRACKET SUBASSEMBLY
8. SUPPORT ARM
9. INTERCONNECTING CABLE ASSEMBLY
10. AUTO RANGING & POWER SUPPLY P/C BOARD
11. SPACER
12. BATTERY CLAMP
13. METER MOUNTING STUD
14. LOG CONVERTER & SUBTRACTION AMPL. P/C BOARD

405-30

Figure 5-6. Component Location, Internal View with P/C Board Removed

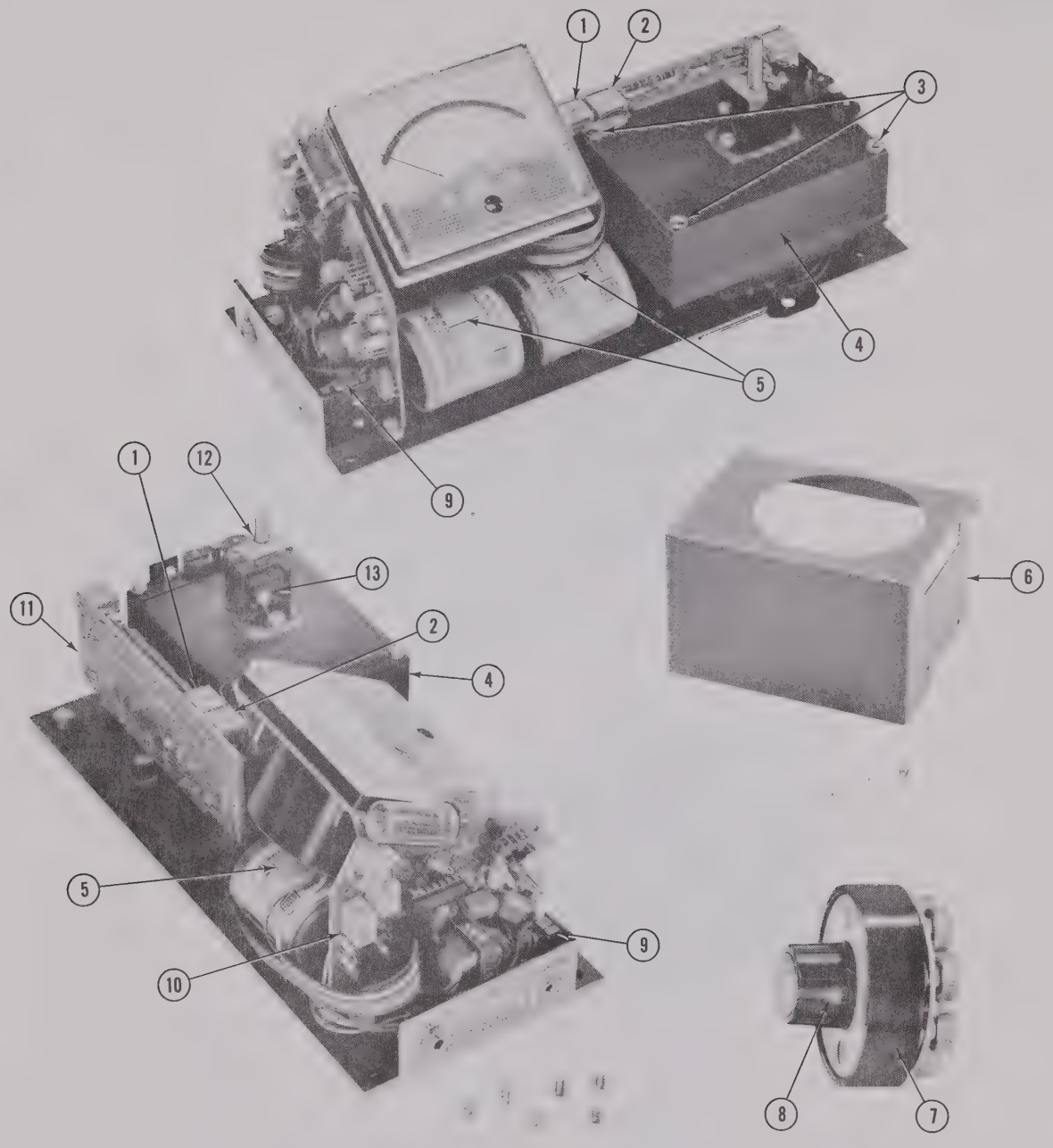


FIGURE 5-7

LEGEND

1. POTENTIOMETER R326
2. POTENTIOMETER R327
3. RETAINING SCREW
4. PHOTODIODE HOUSING COVER
5. BATTERY CLAMP
6. OPTICAL HOUSING
7. KNOB ASSEMBLY
8. SET SCREW
9. BATT TEST SWITCH SW502
10. AUTO RANGING AND POWER SUPPLY P/C BOARD
11. LOG CONVERTER AND SUB-TRACTION AMPLIFIER P/C BOARD
12. SWITCH ACTUATOR
13. PRESS-TO-READ SWITCH SW501

405-31

Figure 5-7. Component Location, Internal View

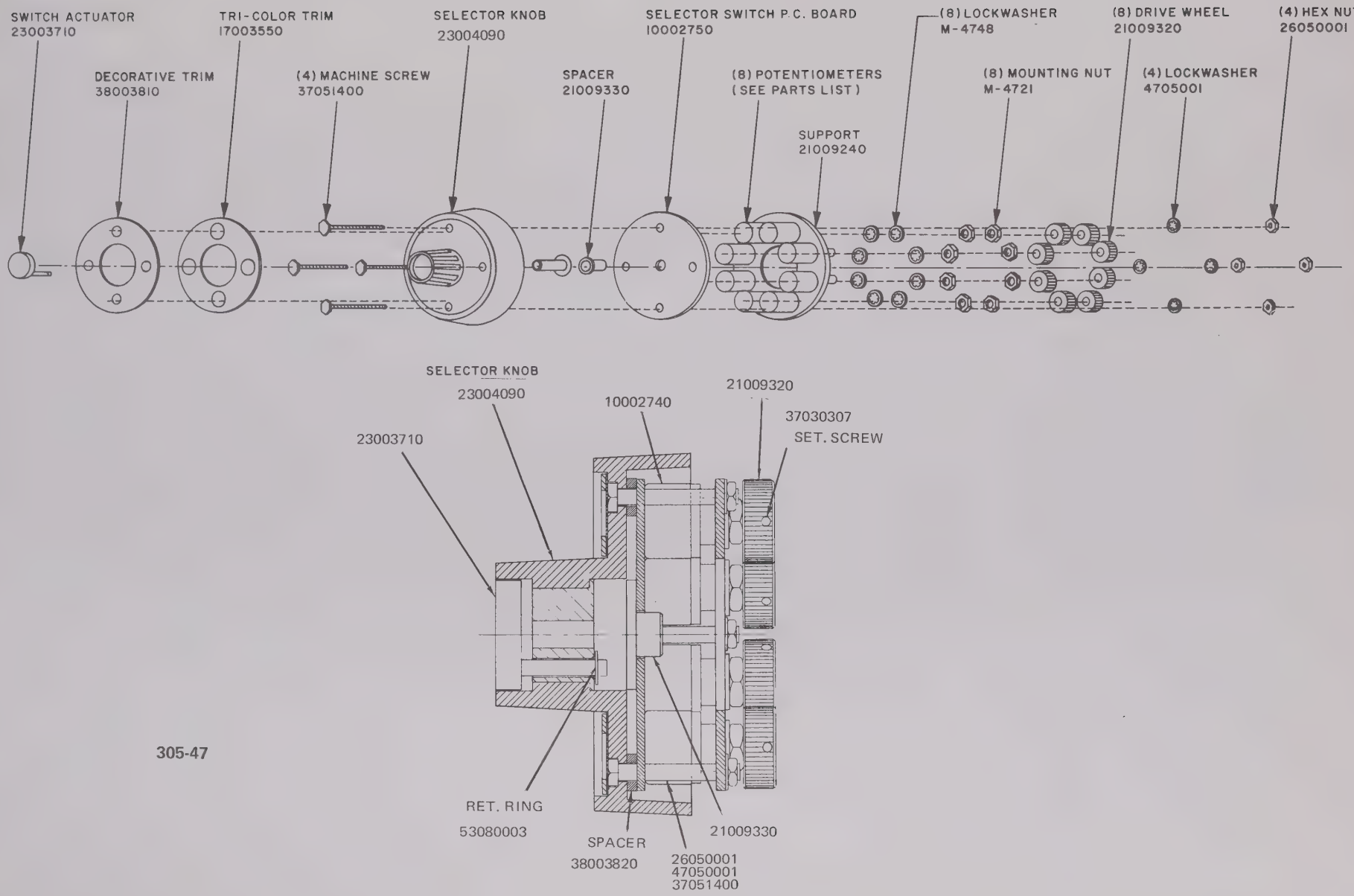


Figure 5-8. Filter Selector Knob Assembly, Exploded View

SECTION 6

PARTS LIST

This section lists and describes the major replaceable parts for the RD-505. All parts have been categorized by functional stage or major assembly. Further, each assembly has been assigned a numerical series for those parts (i.e. electrical and electronic) appearing in figures 7-1 and 7-2 and requiring reference symbol designations.

To expedite delivery when ordering any part, specify the following:

a. Generic name
b. Reference Symbol
c. Part number
d. Model and serial number of the equipment containing the part being replaced; this information can be obtained from the equipment nameplate.

ASSEMBLY	REF. SYMBOL NUMERICAL SERIES	PAGE NO.
Final Assembly	——	6-2
Base Plate Assembly	500	6-2
Optical Housing Assembly	500	6-4
Knob Assembly	400	6-5
Log Converter Assembly	200 & 300	6-6
Auto Ranging & Power Supply Assembly	100	6-7
Charger Assembly	600	6-10

PARTS LIST

FINAL ASSEMBLY (Part #13001200)

REF. SYMBOL	MACBETH PART NO.	DESCRIPTION	MANUFACTURER
	38003990	SWITCH ACTUATOR:	Macbeth
	23003790	HOUSING ASSEMBLY:	Macbeth
		REFERENCE PLAQUE SUBASSEMBLY: (See "STANDARDS HOLDER SUBASSEMBLY")	
	38003930	ACCESS PLATE:	Macbeth
	38003960	TARGET PLATE:	Macbeth
	53008004	RETAINING RING: #5131-12, Type H	Truarc
	29002350	STANDARDS HOLDER SUBASSEMBLY:	Macbeth
	21009220	STANDARDS HOLDER*	Macbeth
	23003860	SWITCH ACTUATOR SUBASSEMBLY:	Macbeth
	23003870	TARGET PLATE SUBASSEMBLY:	Macbeth
	23003900	ZERO PLAQUE SUBASSEMBLY:	Macbeth
	38003970	ZERO TARGET PLATE:	Macbeth
		* Does not contain color chips.	

BASE PLATE ASSEMBLY (Part #10002810)

REF. SYMBOL	MACBETH PART NO.	DESCRIPTION	MANUFACTURER
B501, B502, B503	12000350	BATTERY: Nickel-Cadmium, 2.2 SCL	Gould, National
J501	09020003	JACK: Tini-Jax, Type 41	Switchcraft
J502	21009300	JACK: Micro-Jax, Type TR-2A, mfg by Switchcraft, Modified by Macbeth Corp.	Macbeth
M501	24001120	METER: DC Microammeter, #1921	Weston
SW502	43010200	SWITCH: #11SM-1	Microswitch
	38003910	METER: Bracket	Macbeth
	23003840	CONNECTOR BRACKET & CLINCH NUT SUBASSEMBLY:	Macbeth
	51000060	BUTTON: Battery Test	Macbeth
	10002840	CABLE SUBASSEMBLY: Inter-connecting	Macbeth
	23003830	BATTERY CLAMP & CLINCH NUT SUBASSEMBLY:	Macbeth
	10002720	PRINTED CIRCUIT BOARD ASSEMBLY: Auto Ranging and Power Supply Circuits	Macbeth
	21009160	STANDARDS SELECTOR:	Macbeth
	23003730	SUPPORT ARM SUBASSEMBLY, METER: Right	Macbeth
	23003740	SUPPORT ARM SUBASSEMBLY, METER: Left	Macbeth

OPTICAL HOUSING ASSEMBLY
Part #29002390)

REF. SYMBOL	MACBETH PART NO.	DESCRIPTION	MANUFACTURER
L501	10002780	LAMP AND LAMP HOLDER SUBASSEMBLY:	Macbeth
SW501	43010211	SWITCH: SPDT, #1SX1-T	Microswitch
V501, V502	10002850	PHOTODIODE ASSEMBLY:	Macbeth
	27000460	FIBER-OPTIC BUNDLE:	Macbeth
	21009490	CLAMP, PHOTODIODE:	Macbeth
	23004030	COVER, OPTICAL HOUSING:	Macbeth
	23003850	COVER SUBASSEMBLY, PHOTODIODE:	Macbeth
	29002370	FILTER WHEEL ASSEMBLY:	Macbeth
	21009260	RETAINER, LAMP HOUSING:	Macbeth
	21009620	SPACER: P/C BOARD:	Macbeth
	21009340	CONTACT SUPPORT:	Macbeth

KNOB ASSEMBLY (Part #10002790)

REF. SYMBOL	MACBETH PART NO.	DESCRIPTION	MANUFACTURER
R401 thru R404	36252005	RESISTOR, VARIABLE, COMP: 2.5K ohm, 0.5 watt, ±10%, Type W, w/mtg hdwre.	Allen Bradley
R405 thru R408	36253006	RESISTOR, VARIABLE, COMP: 25K ohm, 0.5 watt, ±10%, Type W, w/mtg Hdwre.	Allen Bradley
	23003710	ACTUATOR SUBASSEMBLY: PRESS-TO-READ Switch	Macbeth
	21009150	SELECTOR KNOB:	Macbeth
	10002740	P/C BOARD, ASSEMBLY: Selector Switch	Macbeth
	21009330	SPACER, FLANGED: PRESS-TO-READ Switch	Macbeth
	21009240	SUPPORT, POTENTIOMETER:	Macbeth
	21009320	DRIVE WHEEL: Zero Adjust or Calibrate Potentiometer	Macbeth

LOG CONVERTER ASSEMBLY (Part #1002820)

REF. SYMBOL	MACBETH PART NO.	DESCRIPTION	MANUFACTURER

NOTE

The Log Converter Assembly comprises both the Log Converter/Subtraction Amplifier and High-Impedance p/c boards. Components contained on these two boards are critically selected and their replacement requires complete realignment and recalibration of the p/c board and of the instrument. For replacement of individual components on the Log Converter/Subtraction Amplifier Board or the High-Impedance Board, the instrument should be returned to the manufacturer for repair and realignment. The Log Converter/Subtraction Amplifier Board and the High-Impedance Board are a matched pair; replacement of the entire assembly (i.e. the Log Converter Assembly Part #10002820) is accomplished as described in paragraph 5-4g.

PARTS LIST (CONT.)

AUTO RANGING & POWER SUPPLY
CKT BOARD ASSEMBLY (Part #10002720)

REF. SYMBOL	MACBETH PART NO.	DESCRIPTION	MANUFACTURER
C101, C102, C103, C104	06680600	CAPACITOR, TANTALUM: 68 mfd, 10v, #196D686X0010FB	Sprague
C105, C106	06220901	CAPACITOR, HYPERCON CERAMIC DISC: .022 mfd, 25v, #HY525	Sprague
C107, C108	06470900	CAPACITOR, HYPERCON CERAMIC DISC: .047 mfd, 10v, #HY310	Sprague
CR101	41100026	RECTIFIER: Full-Wave Bridge, #PF10	EDI
CR102	41100024	DIODE: Zener, 1N4580	Motorola
CR103	41100025	RECTIFIER: #A14D or 1N5060	GE
CR104	41100027	DIODE: 1N461A	Sylvania
Q101	41200016	TRANSISTOR: D43C2	GE
Q102, Q103	41200017	TRANSISTOR: D42C2, Type N	GE
Q104, Q105	41200002	TRANSISTOR: 2N3392	GE
Q106, Q107	41200018	INTEGRATED CIRCUIT: U5B770939X (709c)	Fairchild
Q108	41200011	INTEGRATED CIRCUIT: CA3046	RCA
Q109, Q110, Q111	41200020	TRANSISTOR: 2N3877	GE
Q112, Q113	41200019	TRANSISTOR: 2N5138	Fairchild
Q114		Same as Q104	
R101	36221001	RESISTOR, FIXED, COMP: 220 ohm, ¼ watt, ±10%	Allen Bradley
R102	36180001	RESISTOR, FIXED, COMP: 18 ohm, ¼ watt, ±10%	Allen Bradley
R103	36162000	RESISTOR, FIXED, COMP: 1.65K ohm, ±1%, RN55D	Allen Bradley
R104	36512001	RESISTOR, FIXED, COMP: 5.1K ohm, ±1%, RN55D	Allen Bradley
R105	36602000	RESISTOR, FIXED, COMP: 6.04K ohm, ±1%, RN55D	Allen Bradley
R106	36761000	RESISTOR, FIXED, COMP: 768 ohm, ±1%, RN55D	Allen Bradley
R107	36332003	RESISTOR, FIXED, COMP: 3.32K ohm, ±1%, RN55D	Allen Bradley
R108	36202001	RESISTOR, VARIABLE, COMP: 2.0K ohm, 1 watt, ±20%, #360S202B	CTS Corp.
R109		Same as R102	
R110, R111	36100003	RESISTOR, FIXED, COMP: 10 ohm, ¼ watt, ±10%	Allen Bradley

AUTO RANGING & POWER SUPPLY
CKT BOARD ASSEMBLY (Part #10002720)

REF. SYMBOL	MACBETH PART NO.	DESCRIPTION	MANUFACTURER
R112	36183002	RESISTOR, FIXED, COMP: 18K ohm, ¼ watt, ±10%	Allen Bradley
R113	36103011	RESISTOR, FIXED, COMP: 10K ohm, ±1%, RN55D	Allen Bradley
R114	36903000	RESISTOR, FIXED, COMP: 90.9K ohm, ±1%, RN55D	Allen Bradley
R115		Same as R113	
R116	36453000	RESISTOR, FIXED, COMP: 45.3K ohm, ±1%, RN55D	Allen Bradley
R117	36952000	RESISTOR, FIXED, COMP: 9.54K ohm, ±1%, RN55D	Allen Bradley
R118, R119	36222003	RESISTOR, FIXED, COMP: 2.2K ohm, ¼ watt, ±10%	Allen Bradley
R120, R121	36104006	RESISTOR, FIXED, COMP: 100K ohm, ¼ watt, ±10%	Allen Bradley
R122, R123	36122000	RESISTOR, FIXED, COMP: 1.2K ohm, ¼ watt, ±10%	Allen Bradley
R124, R125	36253005	RESISTOR, VARIABLE, COMP: 25K ohm, #360S253B	CTS Corp.
R126, R127		Same as R116	
R128, R129	36393000	RESISTOR, FIXED, COMP: 39K ohm, ¼ watt, ±10%	Allen Bradley
R130, R131	36471003	RESISTOR, FIXED, COMP: 470 ohm, ¼ watt, ±10%	Allen Bradley
R132	36472001	RESISTOR, FIXED, COMP: 4.7K ohm, ¼ watt, ±10%	Allen Bradley
R133	36202002	RESISTOR, FIXED, COMP: 2.0K ohm, ±1%, RN55D	Allen Bradley
R134		Same as R120	
S101, S102	40140000	SOCKET: 041-001-121N	Barnes Corp.
T101	44000250	TRANSFORMER: M187	Cycle Transformer Corp.
V101	46000024	TUBE: Indicator, B5750, "Nixie"	Burroughs

PARTS LIST (CONT.)

BATTERY CHARGER ASSEMBLY (Part #10002660)

REF. SYMBOL	MACBETH PART NO.	DESCRIPTION	MANUFACTURER
CR601, CR602	41100006	DIODE: 1N3193	RCA
F601	31001000	FUSE: ⅛ amp, 250v, Type AGC	Bussman
L601	20012001	LAMP: #1247	Westinghouse
P602	09010024	PLUG: "Tini-Plug" #750	Switchcraft
R601	36750001	RESISTOR: 7.5 ohm, 3 watt, #VC3D	Clarostat
SW601	43020203	SWITCH: 115-230 volts, #46256LF	Switchcraft
T101	44000240	TRANSFORMER: Power #M185	Cycle Transformer Corp.
	51400710	BUMPER: Rubber #1526	Atlantic–India
	54900040	CLAMP: Tube #C2981-10	Tinnerman
	21009110	COVER:	Macbeth
	23003680	HOUSING SUBASSEMBLY:	Macbeth
	27001670	LENS: Faceted, #514-1008-2131-102, w/mtg nut	Dialco
	05818305	LINECORD: 3½ ft. long, w/3-prong plug	Macbeth

SECTION 7

SCHEMATIC DIAGRAMS

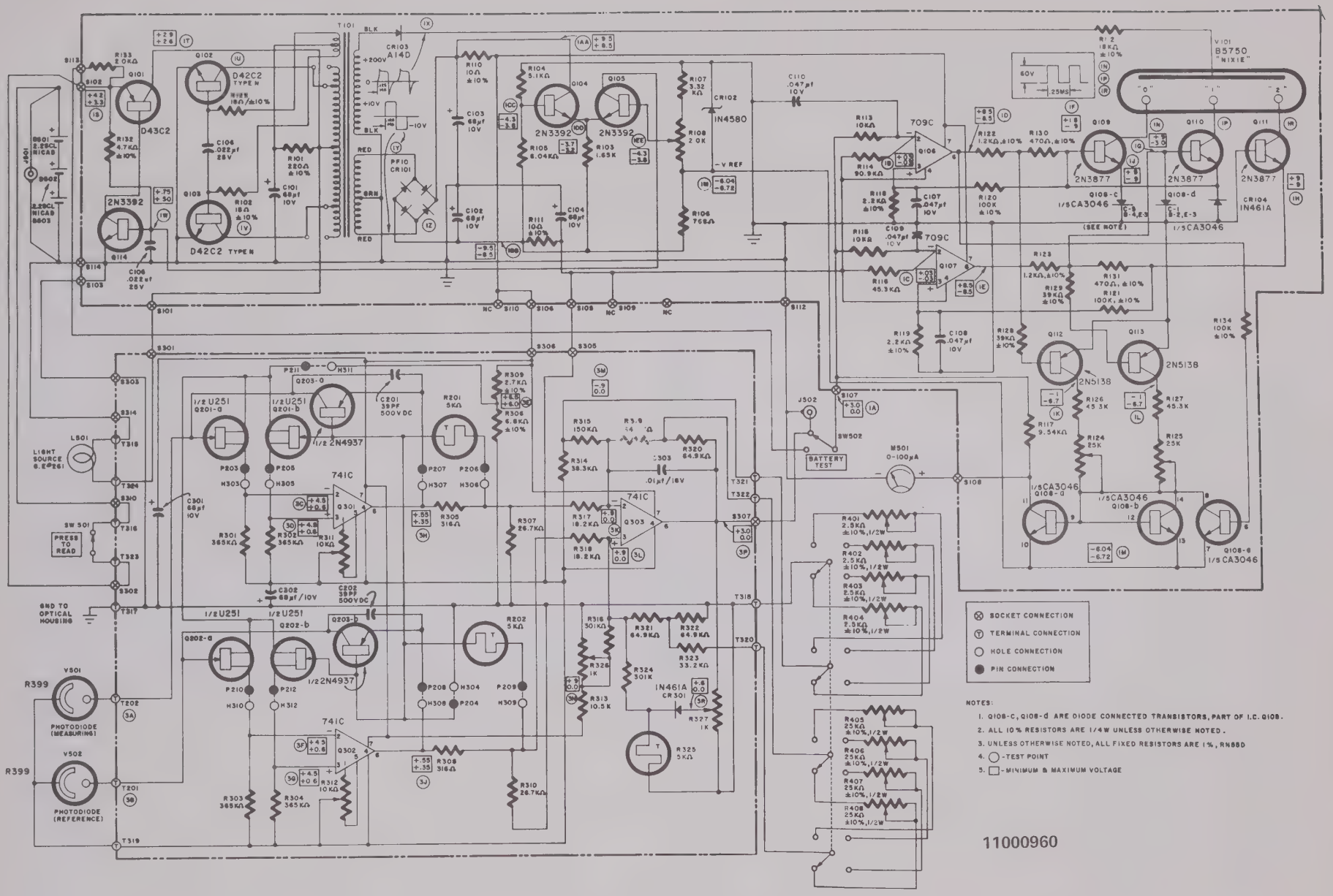

SOCKET CONNECTION
TERMINAL CONNECTION
HOLE CONNECTION
PIN CONNECTION
NOTES:
1. Q108-C, Q108-d ARE DIODE CONNECTED TRANSISTORS, PART OF I.C. Q108.
2. ALL 10% RESISTORS ARE 1/4W UNLESS OTHERWISE NOTED.
3. UNLESS OTHERWISE NOTED, ALL FIXED RESISTORS ARE 1%, RN55D
4. ○ - TEST POINT
5. □ - MINIMUM & MAXIMUM VOLTAGE
11000960

Figure 7-1. Schematic Diagram, RD-505

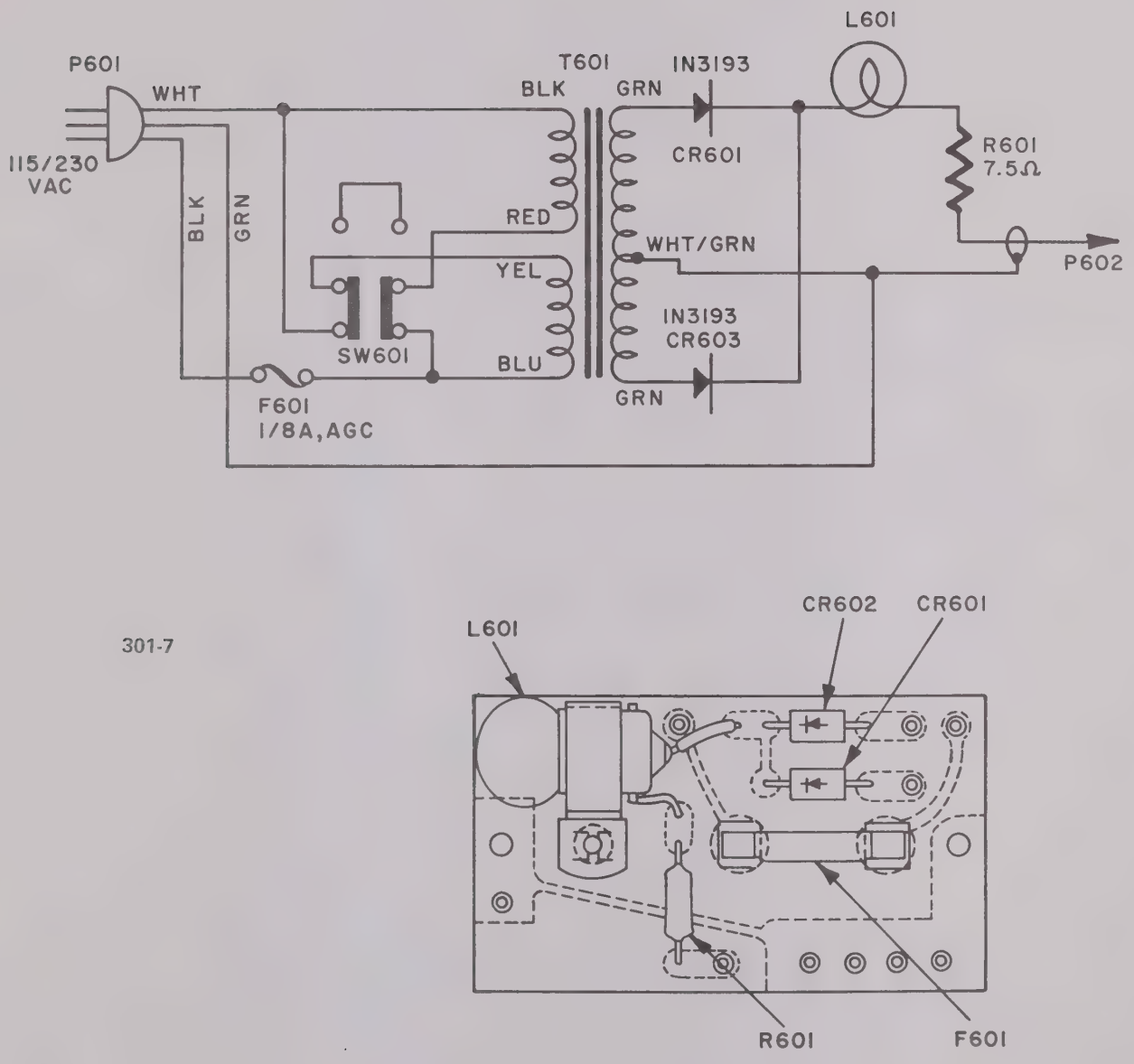


Figure 7-2. Schematic Diagram, Battery Charger

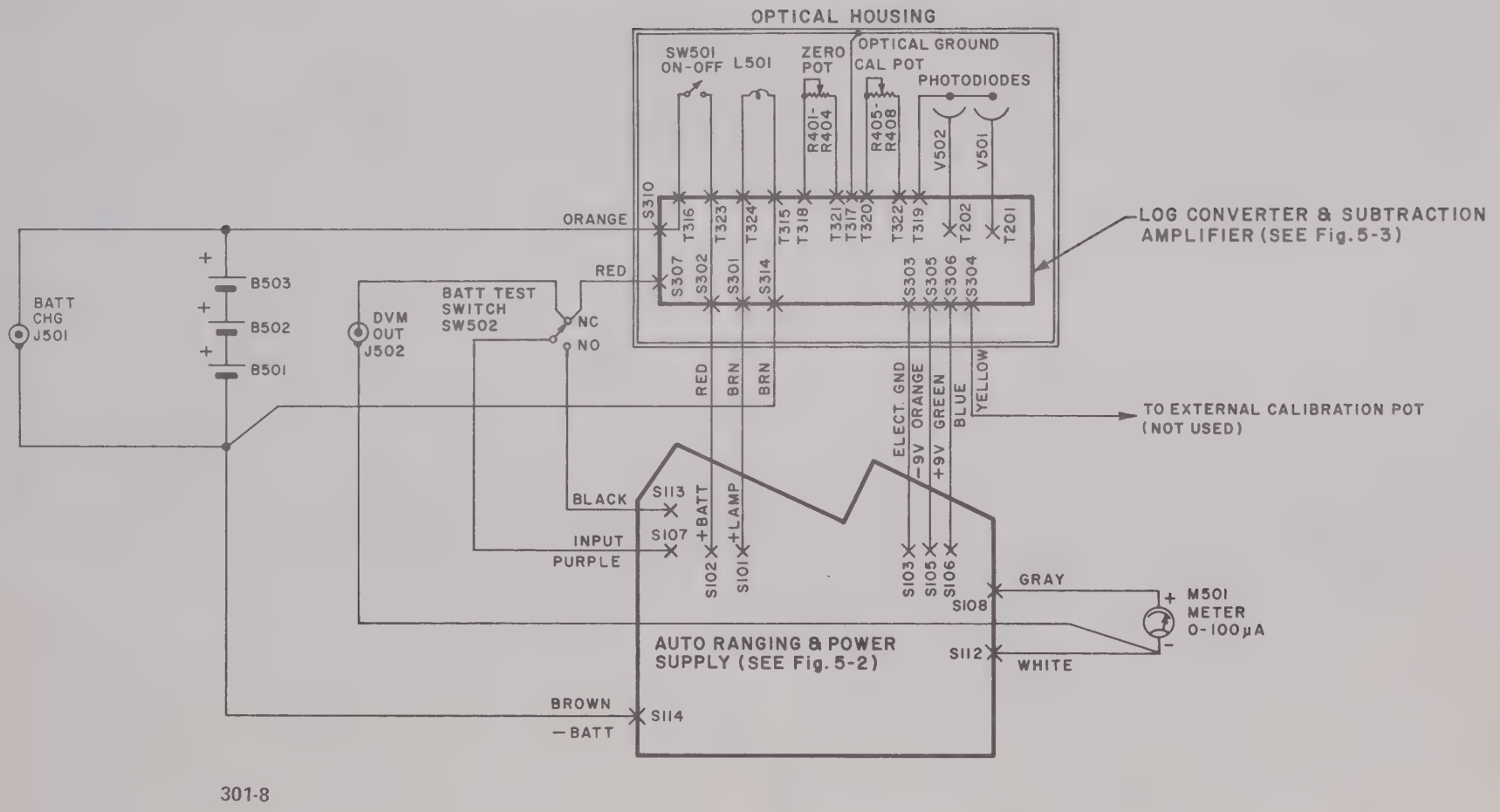


Figure 7-3. Wiring Diagram, RD-505

DATE: March 25, 1974

EQUIPMENT MODIFICATIONS

EQUIPMENT EFFECTED Model RD505

1. Page 6-2 Parts List

Meter M501 (part #24001120), Meter Bracket (part #38003910), and Left Hand Meter Support Arm (part #23003740) have been changed; part numbers, however, remain the same as for original equipment. When ordering replacement parts, an initial order for a replacement meter for units with serial numbers prior to 1600 must specify a new meter bracket and left hand meter support arm subassembly. The Description entry for Meter M501 should be changed in accordance with:

BASE PLATE ASSEMBLY (Part #10002810)

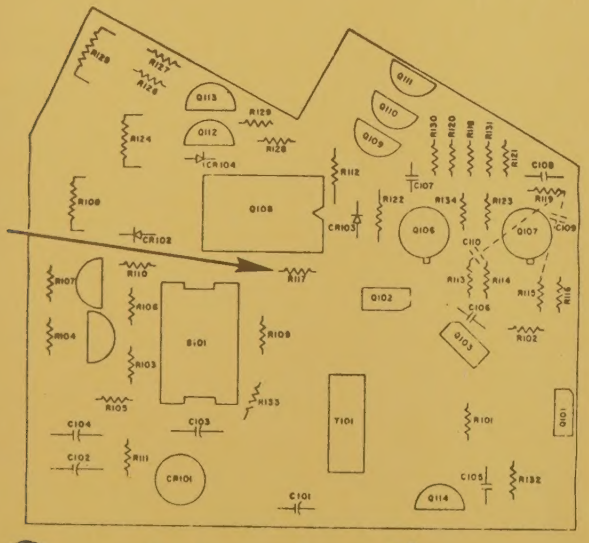
REF. SYMBOL	MACBETH PART NO.	DESCRIPTION	MANUFACTURER
M501	24001120	METER: DC Microammeter, #1941	Weston

2. Page 6-5 Parts List

Resistor R117 (see sketch below) has been changed from 9.54K to 9.09K ohms. The Part Number and Description entries for Ref Symbol R117 should be changed in accordance with:

AUTO RANGING & POWER SUPPLY
CKT BOARD ASSEMBLY (Part #10002720)

REF. SYMBOL	MACBETH PART NO.	DESCRIPTION	MANUFACTURER
R117	36902001	RESISTOR, FIXED, COMP: 9.09K ohm, ±1%, RN55D	Allen Bradley



This change applies only to equipment having the following serial numbers.

1600B and all subsequent serial numbers.

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